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A THEORETICAL SCAFFOLDING FOR CONSIDERING GOVERNMENTAL PRICING POLICIES IN AGRICULTURE[1, 2, 3]

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I

THERE are many facets to the ideological foundations of Democratic-Capitalism as it developed in the United States prior to 1930. But one set of values, which has relevance here, might be expressed as follows: a man's worth is, or should be, measured by his contribution to production; if he labors long and contributes much his return is, or should be, great; and this determination of a man's return, except in emergencies, is a personal thing that occurs, or should occur, outside any form of collective action. Classical and neo-classical economic doctrine which sought to "explain" the workings of Democratic-Capitalism reached the policy conclusion that there was no need for—no logic in—governmental intervention with respect to prices.

On more than one occasion it was argued that the equilibrium price-quantity solutions that obtain under a *perfectly competitive system* yield simultaneously an efficient use of resources and an equitable distribution of the total product. The production of goods and services at the minimum cost position for each firm insures maximum efficiency; the payment of each agent of production according to its marginal product provides a measure of distributive justice.

Actually most practitioners of orthodox economic doctrine advocated

[1] An earlier draft of this paper was read before the National Marketing Research Workshop on Pricing and Trade, Texas A & M College, July, 1952.

[2] Miscellaneous Journal series 787, Minnesota Agricultural Experiment Station.

[3] Many people contributed to the ideas presented in this paper. But the author wishes to acknowledge particularly the helpful criticisms of T. W. Schultz, O. B. Jesness, A. G. Papandreou, Travis Manning, and Roger Gray. Errors of fact, judgment or logic are, of course, the responsibility of the author alone.

some qualification of the above equity solution along the lines suggested by the Christian ethic: e.g., care for the aged, the physically handicapped, and the very needy. And now Welfare Economics tells us that a further condition must be satisfied if the equity solution under perfect competition is to be made consistent with the value-system of Democratic-Capitalism; that condition is that society must be entirely satisfied with the inherited pattern of resource ownership—a rather improbable possibility. But, within the limits imposed by the above restrictions, it still must be recognized that a concept of equity was forged within the discipline of economics (i.e., within the confines of perfectly competitive theory) that was consistent with the prevailing ideology up through the early years of the 20th century.

As we are aware, however, perfect competition is not a reality; it is an abstraction. It happens that this abstraction is useful as a thinking and teaching device. Nonetheless it remains an abstraction; something that does not exist today and never did exist. The norm is some kind of imperfect competition. It is misleading, even false, to argue in terms of economic logic that the equilibrium solutions that obtain for specific markets are either efficient or equitable. We can describe the price-making process in these imperfect markets, and we can trace the consequences of certain types of stimuli (e.g., a change in demand) in these markets, but we have lost our bench mark for appraising efficiency and judging equity. What is required here is that "next step" suggested by Chamberlin over 20 years ago, namely, "the formulation of other than purely competitive criteria by which the results of monopolistic competition may be judged."[4] But that step has never been taken; perhaps it has not because it cannot.

II

In the development of a theoretical scaffolding for considering governmental pricing problems in agriculture let us turn first to the efficiency problem.[5] What specifically is meant by economic efficiency? We have in mind the following concept: the production of that bill of goods and services that maximizes total human satisfaction given (1) the available resources, (2) the level of technology, (3) consumer preferences, and (4) the distribution of income. The price system serves to integrate resource patterns on one hand with demand patterns on the other so that this maximization of total satisfaction may be achieved.

The role of the price system, and the need for an effective price system, is made abundantly clear in this context. The price system in its infinite

[4] *The Theory of Monopolistic Competition,* Harvard University Press, 1939, page 190.

[5] The theoretical scaffolding developed in this paper grows out of the efficiency-equity dichotomy presented so clearly by Tibor Scitovsky in his recent book *Welfare and Competition,* Richard D. Irwin, Inc.; 1951.

complexity, reflecting the myriad of forces in the operating economy, *has the task* of inducing (1) the production of different goods and services in the proportions that best serve consumers' welfare, i.e., the efficient combination of products by the firm and resource allocation between industries, (2) the utilization of factors in the production of goods and services in the most economical way, i.e., the efficient combination of factors by the firm and resource allocation within the industry, and (3) the distribution of those goods and services in best conformity with consumer preferences. In other words, an efficient economy is dependent upon an effective price system.

A general presumption may be said to exist to the effect that the economy is not as efficient as it could be, but that it is tending in the direction of greater efficiency *through time.* This drive toward greater efficiency is motivated by profits and engineered by private firms in the quest of profits; and it occurs in two principal ways: (1) through the static process of variable proportions and, (2) through the dynamic process of innovation. In brief, then, we depend on the workings of the private enterprise economy to carry the principal burden of increasing efficiency. This does not mean that government has no part to play in this respect; by general consensus it does, and we are going to inquire briefly into two such lines of action, but traditionally government's role in this area has not been a dominant one.

One line of action which the Federal Government has traditionally pursued as a means of making the economy more efficient is research and development. And as we are well aware, this type of activity has been well received. Illustrations of government sponsored research and development are not hard to find: the work of army engineers in the 19th century in canal and railroad construction; the development of atomic energy in the past decade, and probably most important, the widespread support of research and development activities in agriculture. The net effect of all this work has been that of increasing the real incomes of individuals through increasing physical productivity.

The second principal line of action has to do with increasing the mobility of resources—making it easier for resources to move into employments that are more productive, hence more remunerative. This line of action is more controversial and has met with less popular success. In fact, we might conclude that success along this line has been negative rather than positive. Government has been used more often to create a restriction to mobility than to remove an existing barrier to movement.

At this point, the rather straightforward, easily visualized goal of efficiency runs up against that complex, ill-defined, poorly measured goal of equity. The limited objectives of this group or that, aimed at enhancing the economic lot of the individuals involved, very often override the

broader efficiency objectives of improved resource mobility. It should perhaps be noted parenthetically that drives by individuals or groups aimed at improving their real goods position may be rationalized in terms of equity, or simply represent crude uses of force, but in either event the distribution of the total product is affected and equity considerations are involved. Whenever the total pie is sliced differently, for whatever reasons, equity questions arise, and that is our concern here.

Government, during the past 50 years, has greatly increased the number and scope of actions taken on problems of equity or distribution; as of 1950, it is to be found in almost every segment of the economy influencing the distribution of goods and services among members of the national society. Very often this form of governmental intervention has concerned itself with price control, management, or adjustment. (The other principal line of action by government with respect to equity has been direct income redistribution by means of income taxes and subsidies.) In each case of price intervention it is safe to presume that some group or set of individuals became dissatisfied with the income effects of the prices received by them and decided to do something about those prices. Where farmers have come to believe that the incomes received by them as derived through the market place are too low, they have called, and probably will continue to call, upon government to raise those prices.

This action on the part of farmer-producers does not seem illogical. If a group of producers believes that the rewards received by them in the market place are unfairly low, *there is nothing in the logic of economics, assuming that the world is real and the market imperfect, to provide a demonstration to the contrary.*[6] From their point of view, and by their standards, they have every reason to petition the government for assistance in obtaining a fairer price—that is, a higher price. On the other hand, neither can the views of William Graham Sumner and Frederick Hayek be disproved; perhaps even under imperfect competition the market yields a just price.

The question may then be asked—But what if actions aimed at the income enhancement of one group relative to another interfere with the goal of efficiency? If the case is clear cut should not the efficiency objective override the distributive objective? There is nothing in economics which suggests that efficiency objectives hold a higher priority than distributive or equity objectives. True, we more often treat with efficiency, but that stems from the consideration that efficiency problems are neater and easier to deal with. However, equity problems in an opulent society such as ours are more acute and more in need of settlement than efficiency

[6] It might be demonstrated in certain cases that the higher prices being sought would lead to inefficiencies, although this is no easy thing to prove. But to the equity argument, economics has no answer.

problems; or so it would seem from reading the newspapers. The really critical problems within our society seem to be those of the distribution of returns in key industries and the relative real income positions of workers in different industries.

It does not follow, either, that attempts to achieve a more favorable return by one group relative to other groups through some type of price management have in all cases violated the efficiency goal. The study of *Burley Tobacco Control Programs* by Glenn Johnson strongly suggests that price supporting operations in tobacco have had the effect of increasing productive efficiency by encouraging greater investments in new technologies.[7] And, some work that we have been doing with potatoes at Minnesota suggests that unit costs may have declined more rapidly and prices averaged lower over the period 1942-50 with the price support program than would have been the case without such a program. In other words, a price program designed to assure potato producers of a "fair" price may have had the effect of supporting the drive toward efficiency through the reduction of price uncertainty.

The argument to this point might be restated in the following terms: (1) Producer groups (or buyer groups) oftentimes become dissatisfied with the income consequences of the prices received by them and invoke the aid of government, where they are able, to obtain higher prices. (2) In the world of imperfect competition the discipline of economics has little to say as to whether a government administered price is either an efficient price or an equitable price. (3) So confronted, the economist is prone to accept the efficiency goal as being either more analytically adaptable or more important and reach the conclusion by *static methods* that price interference to deal with an equity problem impairs the efficiency goal. (4) But economists, *qua* economists, have no logical basis for suggesting a higher priority for efficiency than equity, or conversely. (5) Further, it is not always clear what the efficiency implications may be of price management designed to achieve some equity goal. (6) As matters stand then, the economist has little or no basis for judging the appropriateness or the goodness of governmental pricing policies in agriculture either in terms of efficiency or equity.

III

The question may now be asked—Does this mean that the economist cannot aid in judging the appropriateness or desirability of one price policy over another? And the answer is yes if the economist persists in limiting his framework of analysis to those rigorous, disciplined systems developed by such men as Knight, Stigler, and Robbins over the past 50 years. To offer useful, constructive analyses and opinions in such an area as governmental price policy the economist must be willing and prepared

[7] Kentucky Agricultural Experiment Station, Bul. 580, Feb. 1952.

to reach out into fields untouched by economics for insights, logical premises, and standards of comparison. This is an important point, for where standards of comparison within economics become sterile or obsolete it becomes necessary to use or work with standards developed outside the system of ideas defined as economics. And such will be the method employed here when it would seem to contribute to the solution of a policy problem the core of which is centered in economics.

Our positive argument can best begin with a development of the concept of equity. This paper is not concerned with trying to define in physical terms what may constitute equity in each individual case, for that is an impossible task. It is concerned, for the moment, only with the implications of the concept as used in an economic context. First, it must be a real income concept. Second, it is a relative concept. The concept is concerned with how much I have in the way of material goods and services (or leisure) relative to you.

In this view, equity is a more inclusive concept than price. An appraisal of the equity of a situation requires a quantity dimension as well as a price dimension. For example, the price of cotton tells us little about the incomes of cotton producers; producer incomes, hence equity considerations, depend upon the number of bales sold as well as price. This means that farmers have focused too much attention on the obvious, prices, and in so doing have missed the crux of the equity problem, namely, the distribution of real incomes. In concentrating on prices in their various drives for equity, farmers have created certain efficiency problems with which they were either not concerned or not expecting. In the first instance we might mention the cotton surplus problem, in the second, the accelerated application of capital inputs in potato production. Analyses of, measures of, and programs for equity need to run in terms of real income—not price.

The concept of equity that is outlined below is definitional and operational at one and the same time. It might prove wise to separate these two aspects of the problem, but such a separation is not easily achieved. Let us also be clear that these ideas are presented as suggestions—suggestions intended to provoke thought and discussion. This equity area is such a vital area into which to channel the thinking of economists that this writer is willing to take a leap in the dark in the hopes that others will follow, perhaps with more grace.

This paper suggests without further qualification that the development of the following conceptual lines should satisfy the equity requirements of a free and opulent society such as ours:

Part I: The market constitutes the primary, but not the exclusive arbiter of a man's worth—equity. In other words, the income received through private efforts becomes (or remains) the primary determinant, but not the exclusive determinant, of an equitable distribution of the total product.

Part II: Since markets have a way of becoming imperfect, hence of becoming imperfect arbiters, the achievement of equity requires continuous action on the part of government with the central purpose of inducing resource adjustments: i.e., the inducement of resources to transfer into employments yielding higher incomes. This process is sometimes expected to occur automatically, but it does not; there are too many restrictions to movement, ranging from legal barriers to financial limitations, to permit the process of resource adjustment to work readily and effectively.

Part III: Where the principal determinant of equity is an assisted market, as under Parts I and II, some protection against severe inequities resulting from human failures and social and economic failures must be provided. This protection would take the form of a guarantee to each individual of a minimum level of living with respect to food, clothing, shelter, and education. In other words a floor is placed under the living of each individual below which the level of living is not permitted to fall. The concept of a minimum level of living is not easy to define; it will, for example, vary with the wealth of the society involved. But this insurance principle becomes an indispensable part of the total concept complementing Parts I and II in such a way as to assure the realization of the equity goal.

Our understanding and perhaps appreciation of the above formulation gains somewhat if we inquire into the lines of action required by each of the conceptual parts. In the first place it seems reasonable to attempt to reach the equity goal by means of customary practices wherever possible, hence the reliance on Part I of the tripartite formulation. It seems clear, also, that many private markets cannot produce desired pricing results (i.e., price effects comparable to those that obtain under perfect competition) without aid from government in establishing working rules and effecting resource transfers, hence the line of action suggested under Part II for facilitating the price making process. The pursuit of this line of action would include:

(1) maintaining and improving information services.
(2) eliminating discriminatory barriers to resource mobility.
(3) the maintenance of a comprehensive employment service.
(4) financial assistance in effecting resource transfers (principally human resources).
(5) the retraining or rehabilitation of displaced workers.

But the objection may be raised—these programs cost money; that is correct, and for the very reason that the process of transferring human resources from one occupation to another or one industry to another is a costly one. That is the reason why the process does not take place readily and automatically. Hence the suggestion is made here that costs of mobility be transferred, in part at least, from the individual to society.

Part III of the total formulation is included to insure against human and social failure; it is protective whereas Parts I and II are permissive. Should this line of action take the form of one over-all program under the jurisdiction of a single agency or could it most effectively take the form

of a series of loosely integrated activities under the jurisdiction of several agencies? We do not need to settle that type of administrative problem here. But let us assume that the organizational form becomes that of a series of loosely integrated activities—activities with which we have had some experience in the past or that have been suggested on occasion. The following list describes the content of this line of action fairly well:

(1) A comprehensive unemployment insurance program, with the rate of insurance payments established at a level that guarantees the defined minimum level of living.[8] This rate would need to be adjusted for the provision of certain types of goods and services under points 5, 6 and 7 below

(2) A comprehensive old age and survivors insurance program with rate adjustments as indicated under (1) above

(3) The development of an income support program for farm people comparable to that in points (1) and (2) above, that takes cognizance of the home-business relation on one hand and the absolute need for food supplies on the other:

  (a) The promulgation in depression years of an emergency credit program to enable producers to meet fixed money charges (all that is suggested here is a regularization of what we have done in a haphazard way in the past)

  (b) The payment of a labor-management income to producers in depression years for undertaking new or completing old projects on their farms

    (i) These projects might vary from painting the house and barn to developing a scheme of supplementary irrigation

    (ii) The size of the labor-management payment might be determined either as a *pro rata* share of the producer's pre-depression yearly labor-management income or at pre-depression wage rates in the area

    (iii) The project would need to be a part of a farm-and-home plan

    (iv) Funds required for financing the purchase of materials involved could be obtained from the Emergency Credit Agency

  This part of the program of income support thus turns out to be a variation of the farm and home plan of John D. Black.[9]

  (c) Producers in subsistence agriculture or chronically distressed segments of agriculture would be advised to avail themselves of the opportunity of transferring out of their commodity line or out of agriculture under Part II of the tripartite concept of equity (government action to induce mobility)

(4) A program of payments in kind for the chronically indolent (this action would seem necessary to protect family members where the head of the family falls into this class)

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[8] It can be argued that the rate of insurance payments should vary with the previous income of the unemployed worker. The logic of such a variable scheme is based on the fact that fixed commitments of high income earners tend to be greater than those of low income earners.

[9] *Future Food and Agricultural Policy: A Program For the Next Ten Years*, McGraw-Hill, 1948, Ch. XXI.

(5) Compulsory, free public education through the 12th grade
(6) A comprehensive medical and hospital plan
(7) A comprehensive food and nutrition program involving:
  (a) In-plant feeding at cost
  (b) School lunch feeding at cost
  (c) A national food-allotment program

Some will argue that the protection provided under Part III of the tripartite concept of equity would subvert the incentive to work. It is hard to believe that the provision of a minimum level of living in those cases where income is the limiting factor (which is all the above series of programs is designed to do) would, in fact, destroy the incentive to work in the average income earner in the United States; the drive to increase personal incomes in 1952 is not in the majority of cases to acquire more food or a clean room. It is to acquire semi-luxury and luxury goods such as new automobiles, detached houses, television sets, and sporting goods, none of which need be a part of a consumption minimum.

Others will argue that the economy cannot carry the burden of such a comprehensive scheme of individual protection. The cost of such a program of protection will depend on two considerations: (1) the level at which the consumption minima are established and (2) the number of persons supported at these minimum levels. This latter consideration will in turn depend upon two problematic elements: (1) the extent of indolence in our society and (2) the incidence of economic depression. As is made explicit above, the indolence problem is seen as a minor one, which should contract as individual horizons are lifted. A guaranteed minimum level of living, if that level is not set too low, becomes an important means of maintaining a high-level of economic activity in peacetime through the maintenance of aggregate demand. It follows, then, that the consumption minima might better err on the high side than the low; we might set our sights on the establishment of each minimum at something equivalent to the 12th grade guarantee in education. Given such guaranteed levels, a long first step is taken toward underwriting continued prosperity and a long second step is taken toward the elimination of severe inequities. The situation is a paradoxical one; a bold program of individual protection would certainly make a contribution toward high-level economic activity, hence relieve the pressure on the program of protection itself. Further, as we shall see, an effective solution to the equity problem has beneficial consequences in terms of efficiency. Thus, the summation of *a priori* evidence does not point in the direction of an impossible burden; the balance between costs and benefits can only be ascertained through experience.

It is upon reasoning such as this that the above concept of equity stands. The concept of equity developed above is an open-ended concept with a floor—it seeks to place a floor under life itself but not restrict indi-

vidual initiative; it rests on the absolute moral judgment that the ultimate objective of society is the enhancement of the dignity of each and every individual in the society; and it stands as a tripartite unit—remove any part and the total concept collapses.

IV

If now we can assume that the equity question is settled, we may proceed with the central argument. Where the equity question is resolved without resort to a direct manipulation of prices, the price system, hence price policy, can be viewed in a changed light. It is reasonable and within the spirit of the tripartite concept of equity, that the individual or groups of individuals immediately and directly engaged in transactions should work and maneuver to obtain the best deal possible—for in so doing he or they help determine the ultimate return to themselves, previously defined as an equitable one. Since the equity goal has been achieved, there are no logical grounds for the individual or groups of individuals to petition the government for aid in controlling or managing prices in order to increase the relative return. This man or this group has been guaranteed an equitable portion of the total product via an assisted price system first and the direct income route second. The price system is thus relieved of the dual responsibility of achieving an efficiency goal and an equity goal, *where those goals cannot be achieved in one and the same price.* In this formulation the price system is left with a single ultimate responsibility, the efficiency goal.

Whether a full realization of the tripartite concept of equity would in fact relieve the price system of political pressure cannot be foretold here. It is hoped that the incentive of a more efficient economy on one hand and the appeal of the insurance principle in the form of the consumption minima on the other *would have the effect of shifting the focus of political action from the manipulation of prices to the determination of the form and level of the consumption minima.* Certainly there is no suggestion in this paper that the equity problem should be removed from politics. The determination of the form and level of the consumption minima, as in the case of taxation, is properly a political question demanding political decisions, since governmental actions are involved. We should expect standards developed in such fields as nutrition, medicine, and sociology to assist politicians in the determination of the relevant minima by narrowing and defining the issues, but not to raise questions of distributive justice above politics.

It may seem to some that the writer has moved a mountain, or attempted to move a mountain, to bring forth a mouse. Obviously he doesn't see the problem in this light. In the first place the mountain needed moving: the critical economic problems of our age are equity problems. We

must move into this area with some genuine and bold solutions. And until we do the price system will be *used* by individuals and groups, often with the blessing and assistance of government, to effect some kind of solutions to these equity problems. This must be the case since personal income problems—equity problems—outweigh for each individual the more general efficiency problem. And since so far as the author knows the general efficiency problem can only be solved via the price system, it is worth going to great lengths to deal in an effective way with the equity problem in order to reserve the price system for the exclusive efficiency role.[10]

The question that now poses itself is the following—Where the price system is relieved of the ultimate responsibility for satisfying the equity requirement (i.e., a positive policy with respect to the income effects of price changes is deemed unnecessary), do we require a positive policy on the part of government with respect to the pricing system? It might be argued, for example, following the line of reasoning developed in this article, that the appropriate government policy with respect to prices is "let alone." Here it should be pointed out that the discussion is directed specifically to agriculture in contrast to the equity discussion which by necessity had to be inclusive of all elements of the economy.

If economic systems were static this argument would be unassailable. But more and more we are coming to realize that the important efficiency problems reside in the dynamic sphere. Current prices are not the relevant, critical prices in decision making, except insofar as they provide the best estimate of what future prices may be. The relevant, critical prices for a farm producer are those prices that he *expects* will obtain when his product comes to market. The prices that cause a producer to combine inputs in the way that he does are not current or timeless prices—they are those prices that he expects will exist when the production process is complete. As a practical guide to production planning, a farmer probably assumes one of two things: current prices will remain unchanged—this is the easy, habitual solution; or current prices will be modified by so much up or down depending on the factors considered by the farmer.

These expected prices may take the form of a probability distribution in the mind of the producer, or a single most probable price. Further, the greater the uncertainty about the future, the more likely it is that this most probable price (or the probability distribution) undergoes some sort of discount; uncertainty has the effect of dampening price expectations. Thus it seems that we have two efficiency problems to take into consideration that grow directly out of the peculiarities of the dynamic process it-

[10] In reserving the pricing system to the efficiency problem I am following the lead of T. W. Schultz in his brilliant book *Redirecting Farm Policy*, The Macmillan Co., 1943.

self: (1) producers can never know exactly what the conditions of demand may be at the time their product comes to market, and (2) since certain prices are denied to them in decision-making, they tend to discount uncertain, expected prices and plan against a set of dampened prices.

Professor T. W. Schultz has suggested that the solution to this type of problem lies in: (1) announcing at the beginning of each production period a forward price that is representative of what the equilibrium price will be at harvest or sale time, and (2) supporting market prices at those announced equilibrium prices at harvest or sale time.[11] This is not the answer—for two widely different reasons: one theoretical, one political. In the first instance, finding the guess-estimating of a future equilibrium price and holding it secret is one thing; the guess may be wrong or right, but it has no influence on the event. But announcing the guess-estimate as a guaranteed forward price is quite another thing; such an announcement alters the entire situation—producers discover in varying degrees the extent to which their expectations were "incorrect," and, we may expect, alter their respective production plans accordingly. In this situation we should not expect to find for any particular commodity that the after-the-fact equilibrium price equals the guess-estimated, announced equilibrium price. This conclusion rests on the following logical proposition: given the conditions of demand, there is no reason why the sum of individual outputs induced by a varied pattern of *expected* prices should be equal to the sum of individual outputs induced by an *announced guaranteed* price.

In the second instance, the guess-estimating and announcement of next season's equilibrium price opens the door to all kinds of political chicanery. Bureaucrats will be under tremendous pressure to up the guess-estimates—pressure from interested Congressmen, pressure from vested interests, and bribes from unscrupulous operators. Picture the type of recriminations and calls for investigations that would be made when guess-estimates went badly astray. In short, this type of government programing leads to all that is bad in political behavior and little of the good.

If then, these negative arguments hold with respect to the line of action advocated by Professor Schultz does it also follow that there is no solution to this problem of providing greater price certainty for purposes of production planning? The answer must be in the affirmative if we expect to find rigorous, unique solutions. This becomes clear upon an understanding of the nature of the problem involved. On one hand we seek a flexible price system where the changing price signals direct and redirect resource use. On the other hand, we seek stable prices, through time, for

[11] One can accept the role of forward prices in wartime as expounded in the volume *Redirecting Farm Policy*, but the use of forward prices in peacetime as advocated in the volume *Agriculture in an Unstable Economy*, Chapter XII, would seem to create more problems than it would solve.

purposes of planning and undertaking production processes that occur through time. A complete achievement of either limited objective means a complete violation of the other; hence a compromise is called for.

The following line of action is suggested as a compromise solution: permit a given commodity price to vary between seasons, but only by a certain amount or certain percentage. In the case of wheat "futures," the maximum price variation on the Exchange in any one day is limited to 10 cents up or down from the closing price of the preceding day. It is suggested that this policy be adapted to the needs of agricultural production; in the case of wheat, for example, a specific grade of spring wheat would be permitted to fall by only a given percentage from one season to the next. Without experience it is difficult to say at what point the compromise should be drawn betwen price flexibility and price stability, but a 10 per cent change per season might be suggested. In other words, if a specific grade of spring wheat sold on the average at $2.00 in 1952, then producers would be assured that the price of that grade of wheat would not fall below $1.80 per bu. in 1953 (for practical purposes one would not impose a limitation on the up side). In those cases where commodity prices are highly variable within seasons or between seasons (e.g., truck crops) it might prove necessary to compute the price floor for any current year from a moving average of the previous three years. But there is also a possibility that the introduction of relative price stability for these crops would reduce acre variations, hence dampen down the tendency toward price variability itself.[12]

In this proposed line of action there is some flexibility—there is room for the price signal to move up to any height, but it can fall by only 10 per cent. But the 10 per cent limitation on the low side provides a greater degree of certainty in production planning than would be the case under a completely free price system.

At this juncture some farm people and representatives of farm groups may be inclined to ask—what is there in this type of price policy for us? From the equity slant there is nothing. The type of price policy outlined briefly above is not conceived to guarantee farmers a fair share of the gross national product; it is conceived to cope with specific efficiency problems—but nonetheless important problems. In brief, this policy is advocated to help farmers make decisions as to the best use of resources where the production process is elongated by the growth process.

But what if cotton or egg prices are low—what then? To revert to the discussion of equity, those prices will not be *unfairly* low, because the

[12] Only the bare outlines of this proposed line of action are sketched here. The mechanics of this proposal need to be thoroughly thought through and tested. For example, should the price floor for any one year be supported via non-recourse loans and surplus removal or income payments?

demand for food and clothing will be maintained at all times through Part III of the tripartite concept of equity (i.e., minimal protection for all). If prices of these commodities should become relatively low, it will be due to either of one or two circumstances: producers have ignored the price signals; and in that event we cannot shed too many tears over their plight, or the demand for this commodity is contracting in a rapid or unexpected fashion. In this latter event, price policy takes hold in the very short run of one season. In the longer run, Part II of the tripartite concept of equity (i.e., government action to induce mobility) assumes a dominant role. Programs of induced mobility find their reason for being in this situation. Programs designed to retrain, rehabilitate and relocate displaced human resources would be expected to assist marginal producers in distressed commodities to move into new and more remunerative lines of work.

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In broad terms, then, the policy implications for agriculture of the pattern of ideas presented in this paper are:

(1) The farmer's income position is protected in two principal ways, neither of which is effected through the pricing system directly:
   (a) The demand for food and fiber products is maintained at all times through the maintenance of each individual's income at some objectively determined minimum.
   (b) The farmer's level of living is protected under this general policy as well as the urban dweller's.

(2) Where the farmer's income as determined by prices and quantities in the market place falls to (or in the direction of) the defined minimum as measured in real income, he will be informed of and asked to participate in programs designed to assist him in transferring into more productive, hence more remunerative, lines of work.

(3) The pricing system in this context has only one ultimate responsibility—namely, to provide the signals required in directing resource use. To enhance the effectiveness of the price system in agriculture in this efficiency role, it is suggested that limits be placed on the extent to which prices may fall from one season to the next. This action introduces relative price certainty and contributes to the efficient planning of production.

More important, however, than the particular policy formulation that emerges above, is the scaffolding developed here for analyzing farm price policy. It establishes a systematic and logical framework in which to consider the effects of prices and price changes. Separating the consequences of price changes into two strands, one equity, the other efficiency, permits a clearer formulation of what it is that price policy in agriculture is trying to do and of the problems with which it is logically confronted; hence the chances of effecting reasonable policy solutions are increased.

TEMPERATURE INSURANCE—AN ALTERNATIVE TO FROST INSURANCE IN CITRUS*†

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PRIOR to the creation of the Federal Crop Insurance Corporation through Title 5 of the Agricultural Adjustment Act of 1938, there were a number of attempts at all-risk crop insurance by private companies. Without exception, these ventures into general crop insurance by private companies have been short lived. Writers in the field have attributed failure primarily to (1) lack of adequate actuarial data, (2) adverse selection of individual risks in any given year, (3) adverse selection over time due to late-season sales of insurance, (4) insurance of price as well as physical yield, and (5) inadequate geographic diversification.[1] These reasons for failure, of course, do not apply with equal force to all insurance plans which have been offered by private companies. However, whatever the cause, it is clear that private companies have not met with success in offering all-risk crop insurance to farmers.

The federal crop insurance experiment is now (1951) in its 12th active year. The combined operations over twelve years show an unfavorable loss ratio, although periodic revision of insurance plans based on accumulated experience has contributed to a more favorable premium indemnity balance for recent years. The features of the federal crop insurance plan which have contributed to the unfavorable loss ratio over the years have been suggested by several writers in the field.[2] At least one of the important factors contributing to the failure of several private companies in the general crop insurance field must be excluded since, from the beginning, federal crop insurance has carefully avoided insuring against

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[1] J. C. Clendenin, Federal Crop Insurance in Operation. *Wheat Studies of the Food Research Institute*, vol. 18, no. 6. Stanford University, California, 1942, pp. 275-277.

[2] For a development of various significant ideas with regard to crop insurance and some appraisal of the federal crop insurance program, the reader is referred to: William H. Rowe and Leroy K. Smith, Crop Insurance, U. S. Department of Agriculture, *Yearbook of Agriculture*, 1940, pp. 755-770; J. C. Clendenin, *op. cit.*; Harold G. Halcrow, Actuarial Structures for Crop Insurance, *This Journal*, vol. 31, August, 1949, pp. 418-443; Fred H. Sanderson, A Specific-Risk Scheme for Wheat Crop Insurance, *This Journal*, vol. 25, November, 1943, pp. 759-776; Andrew R. Aandahl, A Crop Insurance Proposal, *Iowa Farm Science*, vol. 1, August, 1946, pp. 12-13; and James L. Buckler, All-Risk Crop Insurance, U. S. Department of Agriculture, Federal Crop Insurance Corporation, December, 1950.

adverse price movements. The important factors which remain, and which must be given the lion's share of the responsibility, appear to be: (1) the absence of adequate actuarial data and (2) the adverse selectivity of risk both over individuals in a particular year as well as over time.

The problem of developing an adequate base for specific-risk insurance is in some respects more difficult than for all-risk insurance. Even if fairly adequate data on yield variation were available, providing a usable base for a combination of a number of insurable natural causes, the problem of isolating yield variation due to a specific weather risk may be troublesome. The purpose of this paper is to explore a temperature insurance scheme as an alternative to direct frost damage insurance. The analysis is specifically oriented toward temperature insurance as an alternative to citrus frost insurance in Southern California, due to the availability of a substantial volume of detailed temperature data for that area. Temperature insurance, if feasible, circumvents the problems arising from inadequate historical data of frost loss in citrus. Furthermore, the difficulties surrounding the enforcement of sound frost protection practices, essential to success in any direct frost damage insurance, are avoided. It will be apparent, however, that temperature insurance does not promise to remove all troublesome problems connected with frost insurance.

Citrus Crop Insurance

All of the crop insurance written by the FCIC prior to 1951 was in field crops and was of the all-risk type. Specific-risk insurance was offered by FCIC on an experimental basis in 1950, covering damage to citrus through wind, hail, and frost. The insurance was offered in selected parts of two counties in Florida, but none was written due to failure to secure the minimum number of applicants per county, as required by law. This writer understands that essentially the same program was offered again in 1951, at which time the necessary participation was obtained in one of the two counties. A complete summary of the first year's experience in citrus crop insurance had not been published at the time of this writing.[3]

The Florida citrus plan is designed to protect the grower's annual investment in his crop. The coverage on each grove is expressed in dollars per acre; the level is determined in a manner which reflects the investment in the crop in the area exclusive of such costs as management and picking. The grower becomes eligible for indemnity payments provided damage due to the insured causes reaches 10 per cent of estimated total

[3] Although this was the first venture by the FCIC into citrus crop insurance, there were attempts by private companies at citrus frost insurance in the 1920's. There was also the attempt by the Growers Insurance Exchange (a reciprocal exchange) to offer specific insurance against frost damage in California in 1950-51. Failure to build up the minimum aggregate surplus deposits required before it could begin operation prevented the GIE from opening business in 1950-51.

production, assuming no damage. For insurable loss above 10 per cent, the indemnity is determined by multiplying coverage by estimated per cent damage. Under the plan, the estimated production and extent of damage for the insured unit are to be determined by the adjuster at the time of inspection immediately after the damage is incurred or, possibly, at the close of the picking season, when more accurate determination of production and damage is possible. In either event, the method of determining loss is specified in the plan.

The premium rates are also expressed in dollars per acre and vary by areas in a pattern which reflects variation in risk involved. The nature of the data available by which the premium rates are adjusted is not clear. Presumably, rate areas have been established in the county based on estimates of loss due to insurable causes in each area during a specified base period.

It is clear that in the Florida plan, as in other FCIC plans, no price insurance is incorporated. It is also clear that, although the insurance contract is not written specifically in terms of yield insurance, yield losses due to insured causes serve directly as a basis for determining indemnity payments and presumably also premium rates. In the case of loss through wind or hail, this loss is determinable directly through complete or sample counts. In the case of frost damage, the full extent of the loss may not be determinable until the fruit is harvested.

In California, neither wind nor hail has been a serious hazard to citrus growers, but losses due to frost have been substantial in at least three of the last 15 years: 1936-37, 1948-49, and 1949-50. An insurance plan which would permit the grower to protect himself against heavy losses in a particular year due to frost might, therefore, find a market in California.

The actuarial analysis underlying a plan of specific-risk insurance differs in important respects from that underlying the all-risk insurance which has been and is still being offered on certain field crops. In all-risk insurance, all that is needed is to study the yield experience of a particular parcel of land or a particular farm over a period of years. If it can be assumed that management practices related to yield have remained uniform over the years, one need only observe the average level and variability of yield to determine premium rates necessary for self-supporting insurance. In such calculations, all departures from the average yield over the base period might be treated as due to the insurable natural causes, and deviations below the average over the entire period might be used to calculate the expected loss cost over a period of future years. Premiums can then be set to cover expected loss costs plus loading, if any, for administrative costs.

In specific-risk insurance, on the other hand, yield losses due to the specific hazard against which insurance is written must be isolated.

Hence, the component of yield variation over some past period due to frost must be isolated if a sound actuarial base for frost insurance is to be obtained.

Without minimizing the difficulties in obtaining an adequate actuarial base in Florida for frost insurance purposes, it must be recognized that the problem is even more complex in California. One important difference is, of course, the prevalence of frost protection practices (orchard heating) in the latter state. Presumably because of the relatively greater frost hazard in California, orchard heating, although not uniformly practiced, has been adopted there much more extensively than in Florida. This means that, in offering insurance against loss by frost to California growers, the insuring agency needs to recognize that the loss experience is at least partially controllable by the insured. On an individual grove basis if the grower has practiced frost protection during the period on which his premium rates are based, these rates will be sound only if he continues uniformly his policy of heating into the period of insurance. Similarly, with groves which have not been heated during the base period, the premium rates will not be sound unless the policy of not heating is continued. In case heating has been practiced in only a part of the base period, the direction of distortion in premium rates will depend upon which policy is followed during the insurance period.[4]

Another dominant characteristic of frost damage to citrus in California is its very spotty distribution geographically. Substantial variation in frost damage apparently occurs within a relatively small geographic area in a typical critical temperature period. This, in effect, reduces markedly the likelihood of success of any "area" insurance scheme due to the almost inevitable selectivity of the high-risk insurance units which would result. This characteristic of frost loss experience also renders the "key farm" procedure, used extensively in all-risk wheat insurance, quite unusuable for premium rate determination in California citrus frost insurance.

Investigation thus far suggests that the prospects of obtaining adequate frost loss data by groves on which to base a sound insurance program are not strong. Although no systematic survey of growers has been made, casual inquiry of industry representatives indicates that the majority of growers have no records from which to obtain sufficiently accurate frost estimates.[5]

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[4] Discussion in terms of practices in a single grove does not, of course, complete the picture. The losses in a particular grove are frequently dependent, in part, upon the extent of heating in the locality. Under extensive heating in a locality, a particular unheated grove appropriately located may receive completely adequate protection from frost damage. Under such conditions, the adequacy of the frost damage experience in this grove as the actuarial base will depend upon the consistency of heating practices in the locality in the future as compared with the past.

[5] In this connection, it is noted that two of the past three years, 1948-49 and 1949-50, have been heavy freeze years. The only other year of near comparable loss

Attempts to construct a frost loss base for "area" insurance have likewise yielded no promising results. The Orange Administrative Committee has made estimates by orange "production forecasting districts" of per cent of crop damaged by frost for those years in which frost damage has been heavy; namely, 1936-37, 1948-49, and 1949-50. No comparable estimates are available, however, for the remaining years. In an effort to construct usable estimates of frost damage for a series of years, this writer experimented with regression relations between the Orange Administrative Committee estimates and critical temperature measures constructed from U. S. Weather Bureau data. Thus far, this procedure has not produced satisfactory estimates, and the possibilities of refinements in technique leading to satisfactory estimates do not appear promising.[6] Moreover, it must be recognized that, even if sufficiently precise estimates of frost damage by "production forecasting districts" could be made, it

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in the past twenty-five years was the crop year, 1936-37. Under such circumstances, loss experience based on a few recent years, as has been typical in crop insurance plans, will most likely be too high.

[6] The absence of a significant relationship between frost damage and critical temperature measures is probably not surprising considering the nature of the data employed. The per cent of crop damaged by frost does not provide a sufficiently sensitive measure of frost damage since fruit damaged only slightly receives the same weight as fruit completely destroyed. It follows that equal magnitudes of per cent damage might represent markedly different intensities of damage.

The weakness of the temperature data for our purposes is also recognized. The indices of minimum temperatures and critical temperature durations used in the analyses were calculated for each "production forecasting district" from temperature records of a number of thermograph stations in each district. Questions regarding the appropriateness of the indices used for our purposes arise on two counts. First, although each temperature record reflects with sufficient accuracy the temperature at the site of the station, it is not known whether averages for the set of stations adequately reflect the temperatures in the district. Secondly, orchard heating is more prevalent in some districts than in others. It has been the policy of the Weather Bureau to locate its temperature stations at points distributed throughout the area in a manner which minimizes the effect of orchard heating on temperature recorded. Otherwise, extensive heating in the area immediately surrounding the temperature station might affect the temperature recorded at that station. Hence, even if the temperature measures constructed for a district adequately reflected level and duration in the district exclusive of heating, the variability between districts in orchard heating suggests the possibility of marked differences in frost damage in two districts recording similar temperatures. If measures of the degree of heating could be entered into the regression analyses, this supposition might be tested. However, no such measures are available.

A third weakness of the technique arises from the possible inappropriateness of the a priori model which is assumed to explain the degree of frost damage. Only critical temperature variables were used. It is possible that other meteorological factors such as wind velocity, cloud cover, dew point, etc., are systematically related to frost damage. If so, our statistical model has omitted relevant variables and may not be expected to yield satisfactory estimates. Adequate data on other meteorological factors were not available for testing this possibility. However, in view of the weak results obtained from the model employed and in view of the a priori plausibility of the assumed temperature-frost damage relationship, it is unlikely that the inclusion of additional weather variables would alter the results significantly.

remains doubtful whether these districts are sufficiently homogeneous with respect to frost damage to serve as a base for a workable "area" insurance scheme.

Temperature Insurance

Protection against catastrophic losses from freeze by California citrus growers might still be possible even though sound frost insurance tied to individual grove or area experience might be ruled out by lack of an adequate actuarial base. One such possibility is the substitution of temperature insurance for frost insurance as such.[7] In such a plan the schedule of indemnity payments could be tied to critical temperature durations at predesignated thermograph stations. An actuarial base for the determination of premium rates is available from past records of temperature durations at each station. The insurance contract could be written in dollar terms with premiums quoted by stations in relation to specific indemnity payments per hour's duration of critical temperatures. Due to the variability of experience at different stations, premium rates and/or indemnity schedules might differ markedly for different stations. Presumably, a grower would ordinarily attach himself to the insurable station nearest his operations. However, for certain locations there exists the possibility that some insurable station other than the nearest one may more accurately reflect temperature behavior in a particular grove. Under such circumstances the grower need not be restricted in his choice of insurance to the nearest insurable station. The decision as to choice of station or stations could be left with the grower and the critical temperature experience of each station could be made available to the grower to aid him in making his decision. Within rather broad limits, the amount of insurance might also be determined by the grower since premium rates would be uniform for all growers attaching themselves to a particular station and the insurance at each station would be self-supporting over a period of years.

Tables 1 and 2, which follow, illustrate some possible plans for a single station in the Pomona-Upland district in southern California, while Table 3, based on still another plan, permits comparison of a number of stations. Premium and indemnity calculations are based on unpublished records of the U. S. Weather Bureau office in Pomona covering the past 25 seasons, 1926-27 through 1950-51, excluding 1931-32 and 1940-41.[8]

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[7] Temperature insurance as here outlined is a form of "weather-crop insurance" considered by Sanderson (Fred H. Sanderson, *op. cit.*) and Halcrow (Harold G. Halcrow, *op. cit.*). It differs from the scheme considered by Sanderson in that premiums and indemnities are tied directly to temperature behavior rather than losses calculated from estimated relations between yield and selected critical weather variables.

[8] Copies of two years' records, 1931-32 and 1940-41, were not available to the writer for these preliminary calculations. For illustrative purposes these data are not necessary. Their omission probably results in a slightly higher premium rate than would be prescribed by the 25 years' data if all years were represented.

TABLE 1. PLANS A AND B: INDEMNITY PAYMENTS PER FIVE DOLLAR ANNUAL PREMIUM AT ONE THERMOGRAPH STATION, POMONA-UPLAND DISTRICT, CALIFORNIA

	Plan A[a]					Plan B[b]
	27° or lower	26° or lower	25° or lower	24° or lower	23° or lower	
	dollars					
Payment per hour	0.42	0.71	1.48	3.52	10.42	
Yearly payments:						
1926–27	3.10	1.83	—[c]	—	—	1.20
1927–28	—	—	—	—	—	—
1928–29	1.24	.59	—	—	—	.46
1929–30	—	—	—	—	—	—
1930–31	—	—	—	—	—	—
1932–33	.21	—	—		—	.06
1933–34	—	—	—	—	—	—
1934–35	1.27	.71	—	—	—	.49
1935–36	—	—	—	—	—	—
1936–37	37.05	49.36	68.41	87.22	115.00	69.52
1937–38	—	—	—	—	—	—
1938–39	1.27	.59	—	—	—	.47
1939–40	—	—	—	—	—	—
1941–42	4.71	5.91	4.44	—	—	2.96
1942–43	2.96	1.78	—	—	—	1.14
1943–44	—	—	—	—	—	—
1944–45	—	—	—	—	—	—
1945–46	.35	—	—	—	—	.11
1946–47	—	—	—	—	—	—
1947–48	1.87	.18	—	—	—	.60
1948–49	25.61	19.95	8.87	2.91	—	12.55
1949–50	35.36	34.09	33.28	24.87	—	25.46
1950–51	—	—	—	—	—	—
Total[d]	115.00	114.99	115.00	115.00	115.00	115.02

[a] Fixed payment per hour multiplied by hour's duration at or below specified levels.
[b] Calculated on the basis of the following graduated schedule of payments per hour of temperature duration within specified temperature ranges:

Critical temperature	Payments per hour's duration			
	Station			
	No. 8	No. 20	No. 25	No. 31
	dollars			
27.0°–26.1°	.13	.31	.07	.13
26.0°–25.1°	.22	.50	.13	.36
25.0°–24.1°	.46	.81	.28	1.20
24.0°–23.1°	1.10	1.58	.58	3.86
23.0° or lower	3.28	3.90	1.22	42.43

[c] Dashes indicate no payment.
[d] Differences from $115.00 due to rounding.

All premium and indemnity rates presented are based on the season average critical temperature durations for the period studied. Hence, the actuarial base for each plan is the same. The expected number of years over which the insurance is self-supporting is the same for each plan and for each station.

Plan A in Table 1 assumes a fixed premium payment of five dollars. Shown in the table are the levels of indemnity payments for each hour's duration under the designated critical temperatures. In this plan the insured would insure himself against temperatures below 27° *or* 26° *or* 25°, etc. For example, if insurance were written against temperatures 27° or less, the insured for his premium payment of five dollars would receive 42 cents for each hour during the season that the temperature at this station was 27° or less. No additional payment would be received for those hours in which the temperature was 26° or less. As would be expected, the indemnity payments per hour increase as the temperature decreases. Also, shown is the total indemnity payment which would have been paid each year, per five-dollar premium, had this plan been in effect during the period observed. The true nature of the insurance is obvious from these figures. The insured would have paid five dollars per year premium or a total of 115 dollars for 23 years. Over the same period, he would have received an average of five dollars per year indemnity or a total of 115 dollars. The indemnity payments are, of course, greater than premiums in the colder years, and less than premiums in the warmer years. The plan is, therefore, simply a plan in which the insured lays away a reserve of dollars in warm years to draw upon in cold years. The insurance plan has an advantage over an individual savings plan in that the insured may draw upon his savings in a particular freeze year for an amount greater than his accumulated premiums up to that date.[9] Another obvious characteristic of this plan is the more even distribution of indemnity payments over the years in the higher temperature coverages. This results, of course, from the fact that there are fewer years in which the temperature drops into the lower ranges.

In Plan B the premium rate is again assumed fixed at five dollars. This plan is based on the graduated indemnity schedule shown in the footnote. To illustrate, indemnity paid per hour of temperatures between 27.0° and 26.1° would be 13 cents. For each hour of temperature between 26.0° and 25.1° the payment would be 22 cents. Similarly, payments of 46 cents, 1.10 dollars, and 3.28 dollars would be paid for temperature durations within the ranges 25.0°-24.1°, 24.0°-23.1°, and 23.0° or lower, respectively. In the body of the table, total indemnity payments per five dollar

[9] In the plans presented in this paper premiums have not been loaded to cover administrative costs. If insurance of the type described were offered, some loading of premiums would be necessary if the operating costs of the insurer are to be covered.

TABLE 2. PLANS C AND D: ANNUAL PREMIUM RATES AND DISTRIBUTION OF TOTAL INDEMNITY PAYMENTS, ONE THERMOGRAPH STATION, POMONA-UPLAND DISTRICT, CALIFORNIA

	Plan C[a]					Plan D[b]
	27° or lower	26° or lower	25° or lower	24° or lower	23° or lower	
	dollars					
Annual premium	5.92	3.52	1.69	0.71	0.24	10.91
Yearly payments:						
1926–27	3.67	1.29	—[c]	—	—	4.30
1927–28	—	—	—	—	—	—
1928–29	1.46	.42	—	—	—	1.67
1929–30	—	—	—	—	—	—
1930–31	—	—	—	—	—	—
1932–33	.25	—	—	—	—	.25
1933–34	—	—	—	—	—	—
1934–35	1.50	.50	—	—	—	1.75
1935–36	—	—	—	—	—	—
1936–37	43.87	34.75	23.12	12.38	5.52	113.94
1937–38	—	—	—	—	—	—
1938–39	1.50	.42	—	—	—	1.71
1939–40	—	—	—	—	—	—
1941–42	5.59	4.17	1.50	—	—	9.15
1942–43	3.50	1.25	—	—	—	4.12
1943–44	—	—	—	—	—	—
1944–45	—	—	—	—	—	—
1945–46	.42	—	—	—	—	.42
1946–47	—	—	—	—	—	—
1947–48	2.21	.13	—	—	—	2.27
1948–49	30.33	14.04	3.00	.42	—	40.96
1949–50	41.87	24.00	11.25	3.53	—	70.40
1950–51	—	—	—	—	—	—
Total	136.17	80.97	38.87	16.33	5.52	250.94

[a] Based on indemnity payments of 50 cents per hour of temperature duration at or below specified levels.

[b] Based on the following graduated schedule of indemnity payments per hour of temperature duration within specified temperature ranges:

Temperature	Payment per hour's duration
27.0°–26.1°	.50
26.0°–25.1°	.75
25.0°–24.1°	1.25
24.0°–23.1°	2.00
23.0° or lower	3.00

[c] Dashes indicate no payment.

premium which would have been forthcoming under this plan are shown. Again total payments for the 22-year period equal total premiums. With regard to the distribution of indemnities over the period, it will be observed that the degree of concentration of payments falls somewhere between 27° coverage and 23° coverage in Plan A.

Table 2 contains comparable information on Plans C and D, both of which assume indemnity payments uniform over both temperature coverage and station and allow premium rates to vary. Plan C assumes a fixed indemnity payment of 50 cents per hour for each hour of temperature below the critical levels designated. It will be observed that average annual indemnity payments equal premium rate in each case. In Plan D, graduated indemnity payments are assumed beginning with 50 cents per hour of temperature between 27.0° and 26.1°, an additional 25 cents per hour of temperature between 26.0° and 25.1°, etc. Following the pattern of Table 1, the distribution of total payments over the period studied are shown along with the premium rates on which the payments are based.

In order that more stations might be compared, the relevant information based on Plan E. is presented in Table 3. The 17 stations included in Table 3 constitute the entire set of stations in the Pomona-Upland Weather Bureau district which have not been relocated during the past 25 years and for which temperature records are available for the entire period.

Tables 1 through 3 present only a few of the possible plans of temperature insurance. The rates have been selected in each case for ease of calculation and may be easily altered to fit more closely the locality relationships between temperatures at stations on which insurance is written and frost damage. Obviously, adjustments in level of indemnity payments will require compensating adjustments in level of premium payments.

Concluding Remarks

Temperature insurance has been presented here as a possible scheme affording some protection to citrus growers against catastrophic losses from frost damage. This alternative form of insurance is presented on the recognition of the absence of historical data on frost damage necessary for the development of a direct frost insurance program. In a realistic appraisal of the possible success of such a program, however, there emerge some rather troublesome problems.

It is characteristic of all direct crop insurance plans that they provide the insured primarily with an opportunity to spread his risks of losses from selected natural factors over time. From the standpoint of the insurer, however, a measure of protection against concentration of indemnity payments in any one year can be obtained in the typical plan by wider geographic coverage. Heavy losses in one locality might thus be partially offset by premium surpluses in others. In the multiple crop plan an additional element of protection against concentrated losses is afforded by diversification over crops.

No such protection against bunching of payments over time is present in the temperature insurance plans presented here. Inspection of the

TABLE 3. PLAN E:[a] DISTRIBUTION OF TOTAL INDEMNITY PAYMENTS PER FIVE DOLLARS ANNUAL PREMIUM SEVENTEEN THERMOGRAPH STATIONS, POMONA-UPLAND DISTRICT, CALIFORNIA

Year	Station															
	No. 8[b]	No. 20	No. 25	No. 31	No. 5	No. 9	No. 13	No. 16	No. 17	No. 18	No. 26	No. 30	No. 39	No. 40	No. 48	No. 49	No. 50
	dollars																
1926–27	1.02	.28	—[c]	—	—	.36	1.16	—	—	—	—	—	—	—	—	—	5.33
1927–28	—	—	—	—	—	2.37	—	—	—	—	.26	.31	—	—	—	—	—
1928–29	.32	4.55	2.22	—	.53	38.92	3.43	—	—	—	7.83	.78	—	.38	—	4.77	5.92
1929–30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1930–31	—	—	5.30	—	—	4.21	.05	—	—	—	1.64	.31	—	—	—	—	3.13
1932–33	—	—	.53	—	—	6.18	.28	—	—	—	.73	—	—	—	—	—	.14
1933–34	—	—	—	—	—	—	—	—	—	—	—	.16	—	—	—	—	—
1934–35	.39	—	1.63	.43	.53	—	.27	—	—	—	2.35	.57	—	—	—	—	—
1935–36	—	—	.50	—	—	—	—	—	—	—	2.39	—	—	—	—	—	—
1936–37	66.29	75.56	33.06	28.51	109.09	10.55	48.98	65.43	105.52	18.55	12.81	41.64	—	66.40	64.03	64.65	40.65
1937–38	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1938–39	.32	1.21	7.13	1.14	—	.66	.87	—	—	—	9.40	5.65	—	1.80	—	.97	—
1939–40	—	—	—	—	—	—	—	—	—	—	.35	—	—	—	—	—	—
1941–42	3.27	.71	1.71	23.07	—	—	—	—	—	—	7.08	2.42	—	1.32	—	3.21	2.30
1942–43	.99	4.63	1.50	1.12	—	.63	3.39	—	—	—	1.76	—	—	—	—	4.25	—
1943–44	—	—	.28	—	—	—	1.45	—	—	—	.46	—	—	—	—	—	—
1944–45	—	—	.84	—	—	—	.07	—	—	—	—	.62	—	—	—	—	—
1945–46	—	.21	1.83	—	—	—	—	—	—	—	4.15	1.59	—	1.03	—	—	.56
1946–47	—	—	.88	2.18	—	1.75	2.15	—	—	1.60	2.02	3.57	—	.19	—	.62	.56
1947–48	.10	.57	20.22	7.33	—	—	1.94	—	—	1.08	4.26	7.33	5.75	2.51	1.00	1.79	1.99
1948–49	12.33	19.96	28.03	33.30	1.34	2.47	4.97	49.57	9.48	80.15	46.39	33.57	78.66	25.67	49.38	22.56	37.74
1949–50	29.97	7.35	8.16	17.91	3.51	32.60	31.25	—	—	13.62	11.03	16.49	30.59	15.70	.59	12.18	15.96
1950–51	—	—	1.16	—	—	14.40	14.74	—	—	—	.10	—	—	—	—	—	.74
Total[d]	115.00	115.03	114.98	114.99	115.00	115.00	115.00	115.00	115.00	115.00	115.01	115.00	115.00	115.00	115.00	115.00	115.02

[a] Calculated on the basis of the following graduated schedule of payments per hour of temperature duration within the specified temperature ranges:

Temperature	Payment per hour's duration																
	#8	#20	#25	#31	#5	#9	#13	#16	#17	#18	#26	#30	#39	#40	#48	#49	#50
26.0°–24.1°	.39	.85	.22	.74	1.64	.53	.20	166.37	.93	1.59	.21	.31	22.73	.57	2.37	.41	.42
24.0° or lower	1.95	2.68	.99	7.94	18.69	4.66	.73		2.51	7.74	1.48	1.25	—	12.18	8.32	1.02	3.11

[b] Station on which calculations presented in Tables 1 and 2 were based.
[c] Dashes indicate no payment.
[d] Differences from $115.00 due to rounding.

various plans reveals in each case and for each station a marked concentration of payments at two points in time; the single year 1936-37 and the two consecutive years 1948-49 and 1949-50.[10] The uniformity in temperature experience at the recording stations in a relatively small geographic area such as Southern California makes concentration of payments inevitable under a temperature insurance plan. It would appear that we have here an extreme case of catastrophe hazard. A sound insurance plan might still be developed under such circumstances but it must be questioned whether 25 years' data are adequate for a sound actuarial base.[11] Granted that the actuarial base appears at least as strong here as in other crop insurance programs, it must be recognized that from the standpoint of the insurer, the consequences of errors in rate determination might be more serious in this case. It is clear that very substantial reserves with which to meet at least one and perhaps two such years would be essential in initiating such an insurance program.

A further possible characteristic of temperature behavior in this area might give rise to a real obstacle to a workable temperature insurance scheme. In the years predating the period analyzed apparently 1921-22 and 1912-13 were years of heavy frost damage, while damage was light in the intervening years. While it does not necessarily follow it is reasonable to suppose that indemnity payments would have been heavy in these two years and light during the intervening period. In the face of this experience, the possibility of some regularity over time in the occurrence of low temperatures cannot be dismissed. Yet, the period of temperature records is hardly long enough to provide a strong test of whether such regularity characterizes temperature behavior in the area.

Whether or not a systematic pattern of temperature variation over time exists, the historical record might well lead growers to believe that such is the case. Under such circumstances it is difficult to visualize the continuing participation which is essential if any one of the plans presented is to pay its insurance costs. Skepticism on this score is intensified by an apparent feeling by growers that indemnity payments under crop insurance must be frequent if insurance is to be worth while. If the pattern of temperature behavior is to some extent predictable, it might well work to the advantage of the insured to time his participation accordingly. The insurer would obviously suffer under such conditions if the plan is based on continuing participation.[12] Obviously, also, errors in timing participa-

[10] At one station, No. 25, 1947-48 was a heavy loss year, and at one, No. 9, heavy indemnities appear in 1928-29, but neither station is typical as is evident from an inspection of Table 3.

[11] Neither of the two years omitted were unusually cold years and consequently indemnity payments in each year would not have been heavy.

[12] The plan need not, of course, be based on continuing participation. If the pattern of participation over time could be predicted, this could easily be incorporated in the premium rate structure.

tion might work to the advantage of the insurer. In any event a sound insurance program might well require the specification of a minimum term of participation in the contract; a minimum perhaps approximating the average length of period between heavy frost damage years in the past. Based on information available for the period since 1912-13 including the two consecutive years 1948-49 and 1949-50 this would suggest a term of around 9 years, although again it must be recognized that the period of record is probably too short to place a great deal of confidence in such a term. Should a minimum term contract appear the only sound one in this instance, the task of selling such a program to growers would likely meet with considerable resistance.

Temperature insurance of the form proposed here simply provides the insured with a plan for laying away premiums in the relatively warmer seasons to draw upon in the relatively colder seasons. For the plan to be successful, the insured must contribute in premiums in the long run an amount equal to indemnities received. With the aid of records of frost damage over some historical period the grower might well provide self-insurance through a private saving plan. The gain from insurance lies in the possibility that accumulated indemnities at any given point in time might exceed accumulated premiums at that date. This might be a real gain to the grower particularly in the event of heavy frost damage early in the insurance program or in the event of several closely spaced years of low temperatures at any point during his participation. The cost to the insured over a long period of participation, provided administrative costs of insurance are excluded, is the interest foregone on his premium surplus over the years. But temperature insurance is little different from direct crop insurance in this respect. It is possible that the manner in which premium rates are determined in the ordinary direct crop insurance program permits the poorer risks to gain at the expense of the better risks. This, however, could not be expected to continue over an extended period and still retain the better risks in the program. Since in the plans here presented each temperature station is visualized as a self-supporting insurance unit and all participants attaching themselves to a single station pay the same premium rates, the problem of risk differentiation does not exist.

Turning to specific distinguishing features of temperature insurance as compared with direct frost insurance, circumvention of the problem of enforcing sound cultural practices, primarily frost protection, stands out as a desirable feature of the former scheme. Eligibility for payment under a sound plan of direct frost insurance would inevitably require performance of certain minimum frost prevention practices by the insured. Under temperature insurance, decisions regarding frost protection are divorced from the insurance itself. The grower would presumably be motivated in this decision by the same factors which he would consider in the absence of insurance. From the insurer's point of view circumvention of the frost

protection problem removes a potentially troublesome administrative task. Also, with respect to the settlement of claims, temperature insurance would seem to offer an easily administered procedure. Data automatically and relatively precisely recorded render the determination of the magnitude of claims a straightforward operation easily performed by a few simple calculations. The relative ease in establishing and settling claims might be viewed as favorably by the insured as by the insurer.

On the other hand, temperature insurance leaves with the insured the problem of establishing relations between temperature behavior at a selected thermograph station and frost damage at the grove location. It is not inconceivable under temperature insurance that the insured might suffer heavy frost losses but receive little or no indemnity because of marked differences in temperature at the grove and at the temperature station. Conversely, it is possible for the insured to receive relatively large indemnity payments in seasons when his frost damage is light. Individual growers might well view temperature insurance as an inadequate substitute for direct frost insurance on this account. Yet, from the historical picture presented here, it is clear that had such a plan been in operation over the past 25 years, aggregate indemnity payments would have been concentrated in the three years in which frost damage was by far the most extensive. Hence, if the remaining troublesome actuarial problems facing the insuring agency could be resolved without destroying the salability of the insurance to growers, temperature insurance might well serve to provide a substantial measure of protection against loss due to frost.

WHAT IS THE PLACE OF THE EQUAL-PRODUCT FUNCTION?

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AS KEYNES once remarked, "The theory of economics does not furnish a body of settled conclusions immediately applicable to policy. It is a method rather than a doctrine, an apparatus of the mind, a technique of thinking, which helps its possessor to draw correct conclusions."[1] But we tend to forget this first principle and cling to the notion that a unique structural formula will reveal the major mysteries of production economics. All of us would like to believe that economic affairs can be arranged in neat and orderly models, and from time to time a fresh wave of enthusiasm and hope is generated by some new analytical device. Once it was cost analysis, another time statistical correlation. Now it is the equal-product function.

The equal-product function, or for those who like new words with old meanings, the iso-quant paradigm, has been hailed as a significant tool in tackling the perennial problem of the most efficient combination of resources. The concept is not new, but the present wave of interest and the extensive effort to apply it in the economy of the individual agricultural firm is novel. Like many explorations in new territory, the preliminary charts, made under pressure of circumstances, have not always been completely accurate. The time has come when the more permanent settlers will have to redraft and reappraise the early maps of the first explorers against a larger perspective. From this appraisal will come confirmation, rejection, and new discovery.

The purpose of this paper is to contribute to the process of constructive appraisal by raising some broad questions as to the place of the iso-product concept in farm production analysis. Is the device helpful in analyzing the economy of the individual agricultural firm? Is it suited to over-all production analysis? Are the more traditional approaches to be superseded or merely reinforced in certain places? These questions can be approached by examining certain applications of the iso-product function in animal feeding.

Iso-quant Analysis in Retrospect

The germinal origin of the iso-quant concept traces back to the intellectual struggles of earlier economists with the demand aspects of the

[1] In the introduction to the Series of Cambridge Economic Handbooks, edited by Keynes.

familiar supply-demand dichotomy. Like those of our own day, economists of the past had more difficulty in treating demand than they did supply. The problem of comparing subjective utilities between individual consumers with different and unique scales of preference led to the development of the indifference curve apparatus as a way out. Edgeworth is usually given credit for its invention.[2] Marshall, following Edgeworth's lead, briefly presents the famous example of the barter of apples and nuts and shows the indifference curve in his mathematical appendix.[3] But it was left to Pareto to develop the full classical treatment of the theory of consumers' demand by this means.[4]

The indifference curve neatly side-steps subjective comparisons by holding total utility constant. The way this is done can be illustrated by an incident in John Leimert's delightful fantasy, "The Swiss Watch." The flying ants who perform the labor of running the watch works, go on strike for wages higher than the current six drops of honey. Says the spokesman, "Six crystalline drops of honey every so often is not enough. What we want is seven drops every so often, or six drops every somewhat less seldom."[5] Here are two points on an indifference contour.

But the escape from the dilemma is partly illusory because total utility does not always remain constant and it becomes necessary to build a family of indifference curves, marshalled in order. In other words, one presently emerges with a whole consumption surface. As has been frequently pointed out, the indifference approach solves the problem by substituting ordinal for cardinal numbers. For those who prefer to say 1st, 2nd, 3rd . . . nth rather than 1, 2, 3, . . . n there is virtue in the method. Nonetheless, the indifference method has considerable merit in handling demand analysis. It provides at least one objective anchor in a sea of subjectivity.

Use of the indifference approach is not new. But Marshall failed to see its potential power and laid it aside in favor of the marginal utility method. Pareto's contribution was long held in eclipse by the splendor of the Marshallian sun. Hicks and Allen have been chiefly instrumental in reviving and giving impetus to this line of thought in recent years.[6]

Although first developed to deal with utility and demand, it was natural to apply the iso-quant apparatus to the analysis of supply. This has some initial advantages from a teaching viewpoint in emphasizing the symmetry of supply and demand. The clear-cut distinction between "combination" and "scale" effects is analogous to that between "substitution" and "in-

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[2] F. Y. Edgeworth, *Mathematical Psychics*, 1881.
[3] Alfred Marshall, *Principles of Economics*, Eighth edition, p. 844.
[4] Vilfredo Pareto, *Manuale di economica politica*, Milan, 1906.
[5] John Leimert, "The Swiss Watch," *The Atlantic Monthly*, April, 1952, pp. 49-53.
[6] J. R. Hicks, *Value and Capital*, Oxford University Press, 1939; R. G. D. Allen, *Mathematical Analysis for Economists*, The Macmillan Co., London, 1938.

come" effects in demand analysis. The troublesome problems related to the valuation of additional production are avoided, although they soon reappear in the valuation of resources added or subtracted from alternative combinations. But supply and demand are far from being symmetrical in all respects. The physical and biological conditions of supply are infinitely more varied than those of demand, and they are also more capable of objective measurement. The assumptions of homogeneity and divisibility that accompany the "pure theory" frequently depart too far from the realities. In agriculture, especially, the indivisible character of many fixed production resources becomes a focal point of reference.[7]

It is well to recall at the outset, that the iso-product contour—the usual graphic way of expressing the equal-product function—is merely a line of equal output on a geometric production surface, just as on a physical relief map, the contours are lines of equal elevation. If we want to climb to the top of a mountain, the elevation contours are useful and help to choose a path. But no one spends all of his time on any one contour. Similarly on a production surface, the final objective is not that of finding the least cost combination for one level of output, but rather the highest profit combination of resources at whatever level it may be. Contours are intermediate tools, not ends in themselves.

In other words, the production contour is only one aspect of a production surface, and not always the most important one. Perhaps a better way to say it, is that a relatively small part of the potential production surface usually has economic meaning and the contours sometimes represent one of the lesser dimensions.[8]

It is possible that we have in the equal-product function a kind of economist's "Northwest Passage" and in the intensity of the search for this Passage into the Pacific, many have been so preoccupied that they have failed to perceive the advantages of alternative routes. The Northwest Passage exists, but there may often be better ways of reaching the Western Ocean.

Animal Production

What follows next is concerned mainly with animal production. Some of the most pressing economic problems in agriculture have to do with the conversion of feed supplies to animal products.

From the viewpoint of the biological processes involved, animal prod-

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[7] For some penetrating comment on this point see Kenneth L. Bachman, "Relation of Economic Theory to the Analysis of Empirical Data in Farm Management Research." *This Journal,* November, 1950, pp. 1159-1168, especially several paragraphs on pp. 1165-1166.

[8] For one of the best expositions of the characteristics of the whole production surface see the article by John M. Cassels "On the Law of Variable Proportions," pp. 223-236 in *Explorations in Economics,* McGraw-Hill Book Co., Inc., 1937.

ucts can be divided into two broad classes: those that result from the growth of the animal, and those that are "manufactured" by the animal. Meats are the principal examples of the first class, and milk and eggs are leading examples of the second. For both classes of production, animal nutrition specialists have divided total feed input into a maintenance and a production portion. In the case of production of the meat animal, the maintenance part of the ration becomes a larger percentage of the total as growth proceeds. In the case of production of milk or eggs, the maintenance part of the ration is approximately constant, and becomes a smaller percentage of the total as the level of production per unit of time rises.

The differences between these two broad classes of animal production affect the way in which the economics of combination of resources may be calculated. For one thing, it is conventional to treat production of milk and eggs on the basis of output per head per year. Production of meat, on the other hand, is conventionally treated in terms of weight, without regard to the time interval. Thus, we speak of feed inputs for a cow producing 8,500 pounds of milk per year. But we say so much feed per hundred pounds of pork. These conventional differences arise from the more fundamental biological differences between the two classes of production. They are important to our problem because the time factor and through it, the feed for maintenance, shows up differently. Time is important to the feed-output relationship because variations in time involve variations in quantity of feed used for maintenance purposes. The more time, the more feed that must be used for maintenance. Any feeding system that slows down the rate of growth in meat production, or lowers the level of production of milk or of eggs, will take relatively more feed for maintenance, and consequently will require more feed per unit of final product. This is one of the primary factors at work in comparing the efficiency of feeding systems that involve variable proportions of roughage.

The cow, or the laying hen, can be regarded as a sort of biological machine producing a flow of output through time. Like a mechanical machine, the biological machine has some physical capacity limits. They may be more flexible but they are limits still. The total capacity for holding nutrients or net energy, can be varied considerably depending upon the proportion of roughage in the feeds. This is more commonly appreciated in the case of the cow, but variations in fiber content of feeds similarly affect the laying hen's capacity. A particular cow, fed to her feed-holding capacity for roughage, may be able to produce 5,000 pounds of milk. But, fed a ration containing concentrates, she may be able to hold enough more nutrients to produce 8,000 pounds of milk.

Equal-Product Function for Milk

With this introduction let us turn to a recent attempt to derive an iso-product contour for milk production.[9] The iso-product function shown in these two articles is in terms of pounds of grain and pounds of hay equivalent per cow. The relationship is shown in a two-dimensional chart with grain on the vertical axis and hay on the horizontal axis. Iso-product contours for 8,500 and 9,500 pounds of milk per cow are presented as "empirical estimates." The contours are concave upward and show distinct curvature, especially toward the high-roughage and low-grain end.

These "empirical estimates" for milk production are derived from a special statistical analysis of certain original data taken from the records obtained in the course of the well-known Jensen-Woodward study.[10] The annual records of 34 individual Holstein and Brown Swiss cows were selected for analysis. The statement is made that after a wide survey of available input-output data the information in the Jensen-Woodward study seemed best suited for the purpose of studying grain-forage substitution relationship. It was recognized that the experiment was not designed for deriving the iso-product contours, but the text states that ". . . the resulting data include an element of feed substitution as well as a pure grain-milk input-output relationship." The analysis then describes a statistical derivation of the grain-forage relationships for two levels of production—8,500 and 9,500 pounds of milk.

The particular statistical process used need not concern us. As in any statistical analysis, the statistics in themselves offer no proof of basic causal relationship. Statistical measures are neutral; they merely show mathematical relationships between numbers. The causal connection must be established by outside logic. This has been well expressed by R. G. D. Allen: "The patterns of scientific phenomena, the laws obeyed and the uniformities displayed, are not provided by mathematics. They are assumed into the system and mathematics can only express and interpret them, help us to deduce their consequences, or to forecast what will happen if they hold, and tell us where to look for verification or contradiction of our hypotheses."[11]

The real issue in this case is whether the original observations arose in such a way as to permit drawing the kind of conclusions represented by

[9] Earl O. Heady, "A Production Function and Marginal Rates of Substitution in the Utilization of Feed Resources by Dairy Cows." *This Journal*, November, 1951. Earl O. Heady and Russell Olson, "Marginal Rates of Substitution and Uncertainty in the Utilization of Feed Resources with Particular Emphasis on Forage Crops." *Iowa State College Journal of Science*, October, 1951.

[10] Einar Jensen, T. E. Woodward, and associates. "Input-Output Relationships in Milk Production." U.S.D.A. Tech. Bul. No. 815, 1942.

[11] R. G. D. Allen, *Mathematical Analysis for Economists, op. cit.*, p. 2.

the iso-product contour.[12] What are the essential conditions? First of all, the iso-product contour is intended to show what alternative combinations fed to a single cow (or to closely similar cows) would produce the same total output. Do the observations in fact represent essentially similar cows fed varying proportions of roughage and grain of similar quality?

If one goes back to the text of Technical Bulletin 815 and examines the background of the Series II Jensen-Woodward experiments from which these records were selected, it is found that all the cows in this Series were permitted free access to roughage and that the total levels of feeding were adjusted through the concentrate ration.[13] Consequently, each cow was consuming up to her *limit* of feed in terms of bulk, for the combination that she received. Thus every single observation represents the right-hand end point of a grain-roughage contour for a specific cow. Any further extension to the right (toward more roughage) is a physical impossibility, and no contour line exists beyond that point. The cow could eat more roughage but her grain intake would be curtailed so much that her total intake of nutrients and her production would fall to a lower contour level.

The different combinations of grain and roughage for cows with approximately the same output must have arisen mainly from accidental differences in physical capacity for holding bulky feed and, perhaps in part, from differences in the character and quality of roughage feed available at different experiment stations, or at the same station at different times. Differences in productive ability may also have been partly responsible.

We may approach the matter in another way by showing what would have been expected if more nearly perfect experimental conditions and control had been present. Suppose that the cows fed at a given level of output had all been identical in feed-holding capacity, productive ability, and had been allowed free access to roughage of the same quality. Under these conditions we would expect the resulting observations to be clustered closely about a single point. This is the straight geometry of it.

Thus we see that the Series II experiments were not only not designed for deriving an iso-product contour, they were quite unsuited for the purpose. Even the most skillful manipulation of the data would fail to elicit any useful information on the point at issue. From the nature of their origin, the data do not contain "an element of feed substitution" in the sense required to build an equal-product contour for the individual

[12] Heady and Olson were well aware of some of the limitations of the Jensen-Woodward data, but they do not seem to have fully recognized the major difficulty. See Heady and Olson, *op. cit.*, pp. 52-54.

[13] Furthermore, the concentrate ration itself was adjusted so as to offset any deficiency in protein, minerals, or vitamins that might arise from changing the proportions of roughage and concentrates. The total ration was at all times balanced with respect to nutrient composition. See Jensen-Woodward, *op. cit.*, p. 12.

cow. The statistical relationships found have been misread because the premises were wrong. The results can be readily explained on the basis of differences in feed-holding capacity, in productive capacity, and in quality of roughage. To deny these differences merely throws one on another horn of the dilemma, for in that case the observations would have lacked scatter and would have formed a close cluster.

Each of the 34 records is a separate and distinct end point on an independent contour line, which runs back in a northwesterly direction. These

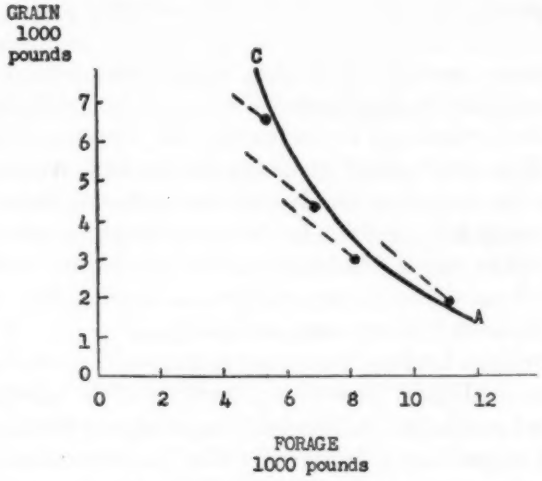

FIGURE 1. THE EDGE OF THE PRODUCTION SURFACE

contour lines are probably parallel to one another but there is no way of learning from the data anything about the shape of the contours. They could be straight lines, convex curves, or concave curves of any degree and still present the same pattern of end points.

We may illustrate the situation graphically by taking four end points represented by the four dots in Figure 1. The short broken lines represent the real iso-product lines that belong to each individual cow. The heavy line AC is a line of best fit for the four observations (and all the others not shown). But AC is not an iso-product line. It is only the line that marks the edge of the production surface. It is the edge of the cliff at which all the real iso-product lines stop, because of the physical limitations of the cow's alimentary tract.

We must therefore conclude that the "iso-product" curve derived by Heady and Olson is without meaning so far as the individual cow is concerned. This does not mean that there is not a real iso-product function for milk production per cow. It only means that the data used were not derived experimentally in a way that would permit establishing the rela-

tionship. A proper experimental design would necessarily involve limitation of roughage feed so that the iso-product contour could be traced back from the full feed-capacity position which represents the end limit of the contour line in the one direction.

The Redman Function

Another and somewhat independent construction of a production surface for roughage-concentrate combinations for milk production is presented by Redman.[14]

Redman's production surface is frankly tentative and conjectural. He states that:

"The acceptable portions of feeding recommendations, certain experimental data available in fragmentary form, and the basic concepts of the economist provide the basis for estimating the empirical data. It is to be pointed out that synthesized production functions will not be highly accurate from the empirical standpoint. Conceptual accuracy rather than empirical accuracy is sought for in this case, though both are ultimately essential." In other words, Redman builds a production surface which is to be regarded as a hypothesis, subject to testing and verification as pertinent experimental data became available.

Redman discusses feeding recommendations and states that ". . . most feeding recommendations assume or imply perfect substitutability between grain and roughage." A little later he points out that ". . . the general recognition of a need for a 'balanced ration' is inconsistent with this assumption." In these statements and in his following discussion of the fragmentary research data that are available, we come to a fundamental and pivotal point. This concerns the nature of the substitution between concentrates and roughage and, particularly, whether the substitution is between specific feeds or in terms of changing proportions of concentrates and roughage in a ration which is kept balanced in nutrient composition.

Careful reading of the literature on feeds and feeding leads to the certain conclusion that the feeding standards and recommendations *do not assume* perfect substitutability between grain and roughage. Specialists agree that a specific grain is not a perfect substitute for a specific roughage. For example, different combinations of corn and alfalfa hay would be expected to show complementarity. But feeding standards and feeding specialists *do assume* that if a ration is kept properly balanced with respect to all the nutrients there will be nearly perfect substitutability between the concentrate and roughage parts of the ration, within a considerable range. The balance is usually achieved by changing the composition of the concentrates.

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[14] John C. Redman, "Economic Aspects of Feeding for Milk Production." *This Journal*, August, 1952, pp. 333-345.

A roughage ration supplemented with enough of the right concentrates to balance it will usually produce more milk than the same TDN from roughage alone, because roughage alone is usually unbalanced. (Some high quality combinations of roughages may be well balanced.) Beyond this point, grain will substitute for roughage on an equal TDN basis up to the place at which physiological difficulties in digestion are encountered, provided the ration is adjusted for balance at all stages, and any nutrient deficiencies are corrected. That is all that the feeding standards say. That is how the feeding specialists interpret them. That is how practical dairymen feed cows.

The production surface for roughage-concentrate combinations on the basis of balanced rations would seem to be the most useful one to envisage; although if the contours are straight lines it is not necessary to construct it at all.

One may also point out that the construction of production surfaces representing alternative combinations of specific feeds may be worthwhile for certain situations. But the endless number of specific combinations of different kinds and qualities of roughage on the one side and the equally large number of specific kinds and qualities of grains and concentrate mixtures on the other, would soon make this a very expensive process.

The Herd Iso-Product Function

Another grain-roughage iso-product function in milk production which may have wider usefulness is the *herd* iso-product function. By varying productivity per cow and the number of cows in the herd, while maintaining the herd output at the same level, considerable variations in the proportion of roughage and grain result. This is a longer run adjustment and in this setting, cows become a significant input factor (especially in periods of high cow prices) and, as cows come in larger packages than grain or forage, the adjustments cannot be made with quite the same ease.

As a matter of fact, the curve derived by Heady and Olson is really an image or reflection of this herd relationship to the extent that it is not confused by differences in the environment and the quality of roughage fed at different stations. This is illustrated in Figure 2, in which the relationship between inputs of roughage and grain are shown on a per 100 pounds of milk basis. (The A curve is derived from data given in Table 27 of USDA Tech. Bul. 815, and the B curve is from Table 1 in Heady's article in *This Journal.*) Inasmuch as Heady and Olson used some of the same basic data, the differences between the two curves arise from the methods of handling the data and from the greater number of observations over a wider range in the Jensen-Woodward report. The Jensen-Woodward analysis smoothed the data and combined the results of a series of experiments in a manner which probably eliminated some of the

discrepancies in environment between stations, including differences in quality of roughage. This accounts for the smaller loss of efficiency as roughage intake is increased than that suggested by the Heady-Olson curve.

The herd iso-product function shown by the A curve has some very practical applications. Considered on a herd basis, a dairyman with a

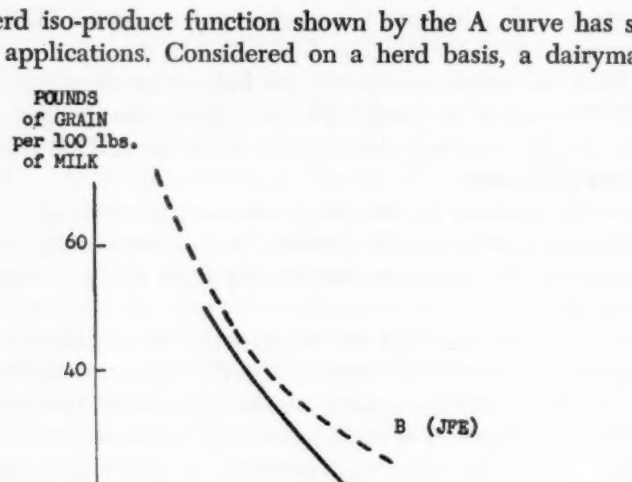

FIGURE 2. GRAIN AND FORAGE PER 100 LBS. OF MILK

specific limitation on his market sales, or a base rating of some sort, will be interested in adjusting the size of his herd and the production per cow, to the least cost point because this will mean the most profitable use of his resources under the market limitation. So far as feeds are concerned, there will be several alternative combinations of roughage and grain among which to choose. The herd iso-product function will assist in this process. As a matter of fact, practical dairymen confronted with such situations do balance affairs by a trial and error process that comes very close to this, although they may never have heard of an iso-product contour. Some of the very real costs of "trial and error" might be eliminated if more were known in advance about the alternative possibilities.

The Example of Egg Production

The biological principles involved in the preceding discussion can be seen even more clearly if we turn to egg production. The over-all feed-egg relationship appears to be such that it is desirable to feed any given ration

up to the layer's full capacity for that ration.[15] The so-called input-output relationship is approximately a straight line up to the hen's capacity and the most profitable feeding level. The hen's ration can be divided between fibrous and non-fibrous constituents in a manner that roughly parallels the roughage and concentrate division of the cow's ration. An iso-product function of the same sort can be contemplated.

However, given the feed-egg relationship just stated, only one point on each contour curve would have economic meaning. The economic part of the production surface becomes essentially a knife-edge following a line of maximum points, each point associated with a different feed combination. In every instance it would pay best to feed the laying hen all she could eat of the appropriate ration. If it paid to feed the ration at all, it would pay best to feed it up to the limit. With this situation, no particular purpose would be served by developing the data for the individual contours, for they would have no economic application. It would be merely an expedition into a never-never land.

But here again, it would be possible to develop a *flock* iso-product function which would represent a constant level of flock production with varying numbers of layers and varying rates of lay, associated with different proportions of fiber or "roughage" in the ration. This would be expressed in terms of feed inputs per 100 eggs. Such a function would be valuable in explaining some of the real variations in feeding practices between regions and would help in finding the most economic ration combinations. It would use the "knife-edge" to cut through to an economic decision.

Iso-product Functions for Bees

A peculiarly interesting example of input-output feed relationships is furnished by modern methods of handling bees. Bees feed on honey (or honey substitute) and pollen (or pollen substitute). The first is a carbohydrate feed and the second is a protein. It has been found that production of honey can be increased several fold, under certain conditions, by giving the bees supplementary feeding of both classes of feed. The advantage comes not so much in the effect on the status of the nutrition of the individual bee as from the effect on numbers in the hive. Bees regulate their numbers in accordance with the feed supply. If supplementary feeding is practiced between important flows of nectar, the number of active workers in the hive is maintained at a higher level and more honey is gathered when a favorable bloom offers a maximum flow of nectar.[16]

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[15] Peter L. Hansen and Ronald L. Mighell. "Input-Output Relationships in Feeding for Egg Production," *Agricultural Economics Research*, January, 1952.

[16] James I. Hambleton and W. J. Nolan, Division of Bee Culture and Biological Control, BPISAE, USDA have kindly commented on this point as follows: "The primary object of the supplementary feeding is to bring an increase in numbers in a colony or, at least, to have it suffer no loss in numbers. A mere increase in numbers

In the case of the bee, it is obvious that any attempt to deal with an iso-product function for a single bee would be meaningless from the practical viewpoint. No doubt there is such a function, but through some instinctive mechanism bees control their numbers at a level that permits the maximum number of healthy workers to subsist on the available feed supply. Apparently some approximate balance is struck between the protein and carbohydrate portions of the feed for individual bees.

In this general situation, it is not certain that there is a meaningful iso-product function (between honey and pollen in the feed supply) for honey production from a hive or colony of bees. The available supply of pollen is a limiting factor, but as it seems probable that honey and pollen are eaten by individual bees in nearly fixed proportions, the net effect of increasing supplementary pollen feeding is simply to increase the number of bees and (if other conditions are favorable) total honey output. There is no practical possibility of fixing the total output of honey at a given level and of varying the feed input per colony. Evidently the feed-input–honey-output relationship with most meaning is one of variable inputs and variable outputs.

Other Examples of Biological Machines

Milk, eggs, and honey are three products from animal "machines," each differing in important respects. In none of the three does it appear that the iso-product curve for the individual animal has much economic significance. For production of honey, it may be impossible even to establish such a relationship. For production of eggs, the relationship could be established, but it would never be economic because it would involve feeding a hen more expensive feeds on an essentially straight line contour for fibrous and non-fibrous elements in the ration. For production of milk it could be established, but, for all usual ranges of production, the relationship would be like that for eggs and would not pay.

For milk and eggs the iso-product function on a herd or flock basis may have considerable usefulness and meaning; for honey the concept on a hive or colony basis apparently lacks significance.

A few examples from the plant world may help in final clarification. Let us consider the annual harvests from perennial trees, such as fruit or rubber trees. Here we have a plant "machine" with a recurring annual

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of bees by extra feeding will not automatically bring about an increase in honey production in the sense that an automatic increase in meat, milk production, or eggs is to be expected with an increase in feeding rations of the right sort to cattle or poultry. For the increased numbers of bees to mean an increased honey crop there must be an abundance of bloom available to the bees, proper weather conditions and expert management. At times an increased number of bees might mean a decreased honey crop because of an insufficiency of bloom and because of heavy maintenance consumption by the large numbers of bees."

product. Most of the costs in production of oranges, for example, are the sunken or fixed costs involved in planting and establishing the grove. Under irrigation, this may include some of the overhead in the irrigation system—although part of the overhead costs for water may be included in the current operating charge so far as the grower is concerned.

If price relationships are such that it pays to operate the orange grove at all, some minimum part of the variable operating costs may actually also be fixed. But beyond that point they are variable. The quantity of water, the hours of labor, the pounds of fertilizer and so on, may all be variable. In ordinary practice, the grower applies as much of each factor as he thinks will pay. Not much thought has been given to the possibility of an iso-product function that would show the least cost combination to produce a given level of output either per tree or per grove. Under most economic circumstances there would be little point in such calculations because it would imply operating a plant, with heavy fixed investment, below capacity. Proposals for limiting aggregate production in times of surplus have seldom gone so far as to suggest controlling the input factors for the purpose of holding down production per tree. The fact that this would increase the total cost per unit of output has been considered sufficient evidence of inefficient use of resources.

Meats and Biological Growth

The equal-product function in meat production, as noted earlier, has a great deal of economic meaning.[17] Assuming that the market demand calls for a specific weight for a hog, a broiler, or a beef animal, alternative combinations of roughage and concentrates (or protein and carbohydrates) can be used to attain the desired weight. Considerations of quality may or may not enter. If the alternatives are those of roughage and concentrates, the time factor comes in—it takes more time with more roughage—and this means more maintenance. Hence, the iso-product contour becomes curved. Useful answers may be obtained for equal-product feed substitution in the case of hogs, beef, lamb, broilers, and other meats. But it needs to be recognized that there are special circumstances that are unique for each class of livestock and which require separate treatment. For example, lengthening the feeding period may be less feasible for commercial broilers than for larger animals. A longer feeding period might reduce the number of lots that could be handled per year with the same labor and equipment. It may usually be most profitable to use a ration with as little fiber as possible so as to grow the birds out rapidly. Hogs have a special problem in the changing characteristics of the carcass at different weights. And so on with each kind of meat production.

[17] See for example the hog analysis by Heady and Olson in "Marginal Rate of Substitution and Uncertainty in the Utilization of Feed Resources," op. cit., pp. 60-64.

Over-all Analysis

The equal-product approach thus occupies its particular niche in the analysis of the economics of the individual firm, along with other more conventional procedures. Farm operators may be less concerned about the combinations of resources for a constant level of production than about adjusting both resources and the level of output to make the most money. Of course the economist using this tool thinks not of one contour but of the whole family of related contours, the entire production surface. The focus is on the contour aspect of the surface, and this may sometimes seem confusing to the practical farmer with his eye more directly on the main chance.

Beyond the individual firm, the iso-product procedure also has a special place in broad aggregative analysis. For example, the more economical use of the national feed supply by feeding better balanced rations can be illustrated in this way.[18] The same total production of livestock may be achieved with several different combinations of feeds.

The kind of linear-programming recently presented by Waugh in an intriguing paper is another instance in which the salient objective is to find the least cost combination of feeds to meet a specified set of nutritional requirements.[19] This is a problem that concerns the individual farmer, too, but obviously the aggregate application in the mixed feed industry is of very great economic significance. There may be a number of examples of this sort in other kinds of farm production.

Some applications in connection with national or regional production goals may be possible. The whole problem of whether the attainment of a given production of corn, or cotton, or some other crop can best be reached by expanding acreage, or by increasing inputs of fertilizer or of other resources, may be subject to such treatment. Viewed in this light, the iso-product function is a useful device in aggregative analysis.

Conclusion

Enough has been said to support the belief that the equal-product function is a handy item to have in the economist's box of tools, but it is no general-purpose monkey wrench. The appropriate tool or combination of tools for each occasion in biological problems will depend upon the specific circumstances. The facts of life even for the birds and bees have some significant variations that preclude any uniform prescription. The production economist engaged in the practice of his profession must pro-

[18] See R. P. Christensen and R. L. Mighell, "Food Production Strategy and the Protein-Feed Balance." *This Journal*, May, 1951, pp. 183-191.

[19] Frederick V. Waugh, "The Minimum Cost Dairy Feed," *This Journal*, August, 1951, pp. 299-310.

ceed like the family physician. He needs to keep in mind the individual firm as a whole and to treat each specific problem in terms of its relationship to the entire organism.

Use of the iso-product apparatus in analysis of the individual agricultural firm, as with any other device, should be prescribed for those cases in which it fits. Its use in over-all aggregative analysis may also turn out to be significant.

A FOUR-EQUATION MODEL OF THE FEED-LIVESTOCK ECONOMY AND ITS ENDOGENOUS MECHANISM*

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THE demand and supply functions for some agricultural commodities imply an "inner mechanism" which, in the absence of other factors such as weather, would generate an endless series of price and production observations for successive years on the basis of specified initial conditions. A simple system of this sort that is familiar to agricultural economists is the "cobweb" model described by Ezekiel.[1] For any given commodity, there is some interest in knowing whether this inner or "endogenous" mechanism is essentially a stabilizing factor, or whether it tends to perpetuate cycles of considerable, and possibly ever-increasing, magnitude.

A model along these lines was developed to study the effect of support programs for corn on prices of corn and on production of livestock products over a series of years.

Four equations are given that can be used in sequence to follow through the effects of changes in feed supplies or consumer income on livestock production and on feed and livestock prices or to study the effects over time of alternative support programs for corn. These form a system of simultaneous linear difference equations.[2] In this paper, a brief discussion is given of the rationale behind the model and of the statistical methods used in obtaining the constants, and a detailed explanation is given of the computations involved in analyzing the endogenous mechanism.

The Feed-Livestock Economy

The general interrelationships between supplies of feed, animal units fed, production of livestock, consumer income, and prices of feed and livestock are shown in Figure 1.

In any given year, supplies of feed are mainly determined by non-price factors. In this set of equations, the supply of feed is considered as an exogenous variable, that is, one that affects the endogenous system but is

* The research on which this report is based was made under authority of the Agricultural Marketing Act of 1946 (RMA, Title II). William J. Baumol, of Princeton University, outlined the mathematical computations. Karl Fox and Malcolm Clough, both of the Bureau of Agricultural Economics, made a number of suggestions in connection with the development and application of the model.

[1] Mordecai Ezekiel, "The Cobweb Theorem," *Quarterly Journal of Economics*, 1938.

[2] See William J. Baumol, *Economic Dynamics*, New York, 1951, particularly pp. 107-217.

not affected by it. Factors that affect the number of animal units fed also affect the amount of feed fed per animal unit. For this reason, they are grouped together in the diagram. From 1922 to 1942, 86 percent of the year-to-year variation in the number of grain-consuming animal units fed during the year was associated with changes in total feed concentrate supplies and with the level of corn and livestock prices in an earlier period. Because of diminishing returns, changes in the number of animal units cause changes in prices of feed and result from them as well.

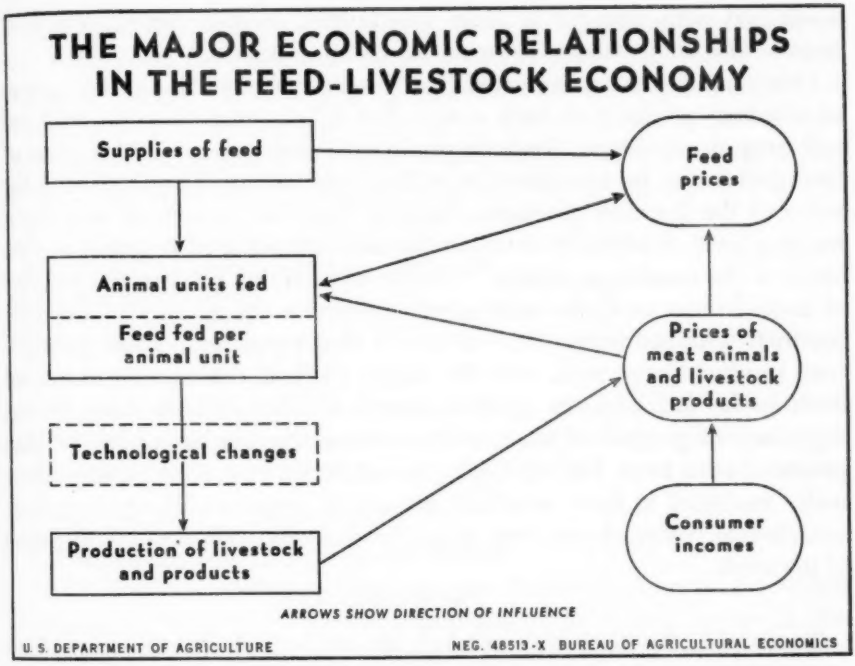
THE MAJOR ECONOMIC RELATIONSHIPS IN THE FEED-LIVESTOCK ECONOMY
Supplies of feed
Feed prices
Animal units fed
Feed fed per animal unit
Prices of meat animals and livestock products
Technological changes
Consumer incomes
Production of livestock and products
ARROWS SHOW DIRECTION OF INFLUENCE
U. S. DEPARTMENT OF AGRICULTURE
NEG. 48513-X BUREAU OF AGRICULTURAL ECONOMICS

FIGURE 1. A DIAGRAM OF THE MAJOR ECONOMIC RELATIONSHIPS IN THE FEED-LIVESTOCK ECONOMY

When the number of animal units on farms at any given time is small, higher livestock-feed price ratios (and, therefore, relatively lower feed prices) are required to move a given supply of feed into consumption than when the number of animal units is large.

Production of livestock and livestock products might be expected to depend mainly on the number of animal units fed, the rate of feeding per head, and certain technological factors, such as changes in breeding and methods of feeding. During the interwar period, 71 percent of the year-to-year variation in the quantity of livestock and livestock products produced for sale or for home consumption was associated with changes in the number of animal units fed. Rate of feeding apparently did not have

a significant effect. This probably reflects, at least in part, the fact that sales of livestock products at times differ considerably from their production. The sales series was used as the dependent variable in this equation so that it, in turn, could be used as one of the independent variables in the analysis of factors affecting the price of livestock and livestock products.

Prices of meat animals and livestock products are determined mainly by the marketing of these products, during the period under consideration, and by the level of consumer incomes. From 1922 to 1943, 96 percent of the year-to-year variation in calendar year prices of livestock was associated with changes in these two factors. In this model, consumer income also is considered to be an exogenous variable.

Other analysts have indicated that prices of feedstuffs adjust to prices of livestock products in such a way that in any crop-year the feed fed will very nearly equal the feed produced. Breimyer said, "the price of feed grains may be considered to be that price which is equivalent to the value of the livestock products obtained from the last unit of feed input fed at a level of intensity at which the total units of feed required are the same as the number available."[3] Due to diminishing returns, the number of animal units on farms will largely determine the amount of livestock products obtained from "the last unit of feed input fed." Thus, prices of feed result, in large part, from the supply of feed, the number of animal units to be fed, and the level of livestock prices. These three factors explained 91 percent of the year-to-year variation in November to May prices of corn from 1921 to 1942. (About 60 percent of the corn is normally marketed in these months.) Around 64 percent of the year-to-year variation in prices of corn was associated directly with changes in prices of livestock.

The Model

To simplify the discussion, symbols are used which denote the particular variables involved. The following variables were used in the system of equations:

C—Price received by farmers for corn, which is assumed to be representative of the general price level for all feeds, in cents per bushel.
S—Supply of all feed concentrates, in million tons.
A—Number of grain-consuming animal units fed annually, in millions.
L—Price received by farmers for livestock and livestock products, index numbers (1910-14 = 100).
Q—Production of livestock and livestock products for sale and home consumption, index numbers (1935-39 = 100).
I—Personal disposable income, in billion dollars.

All of the equations were fitted by single-equation least-squares tech-

[3] H. F. Breimyer, "The Efficiency of Feeding Livestock." *This Journal*, 1943, p. 609.

niques using data for approximately the crop years beginning 1922 through 1942. As the equations are based on the relationships implied by Figure 1, they can be considered as structural equations in the Cowles Commisson sense. As most of the relationships are believed to be multiplicative rather than additive and as the relationships are believed to be more stable in percentage than in absolute terms, all variables were expressed in logarithms. The statistical aspects of these analyses will be discussed in more detail in a bulletin to be issued by the Bureau of Agricultural Economics. The economic aspects are considered in Technical Bulletin No. 1061 entitled "The Demand and Price Structure for Corn and Total Feed Concentrates" by Richard J. Foote, John W. Klein, and Malcolm Clough. In the following equations, Δ equals the change in a particular item from the preceding year. The numbers in parentheses underneath the regression coefficients are their respective standard errors.

$$\underset{}{(1)\ \Delta C = .00373} \underset{}{- 2.36\Delta S} \underset{(.24)}{} + \underset{(.57)}{1.94\Delta A} + \underset{(.18)}{1.13\Delta L} \qquad R^2 = 0.91$$

$$\underset{}{(2)\ \Delta A = -.092} + \underset{(.040)}{.214\Delta S} - \underset{(.032)}{.185C'} + \underset{(.036)}{.207L'} \qquad R^2 = .86$$

$$\underset{}{(3)\ \Delta Q = .00369} + \underset{(.090)}{.562\Delta A} \qquad r^2 = .71$$

$$\underset{}{(4)\ \Delta L = .00578} \underset{}{- 2.08\Delta Q} \underset{(.25)}{} + \underset{(.08)}{1.45\Delta I} \qquad R^2 = .96$$

ΔQ is assumed to be a direct function of ΔA, since feed fed per animal unit had the wrong sign and did not have a statistically significant effect on livestock production. Therefore, equation (4) can be rewritten as:

$$(5)\ \Delta L = -.00190 - 1.17\Delta A + 1.45\Delta I.$$

If this is done, equation (3) can be omitted.

These analyses were used in sequence to follow through the effects of changes in supplies of feed and in consumer income on livestock production and on prices of feed and livestock with alternative support programs for corn. The relationships are not assumed to take place simultaneously, but instead to occur in sequence within the year. For this purpose, two types of deviations from reality were made: (1) aggregates for the livestock industry were used, whereas it is realized that the time sequences would be much different for beef cattle, say, than for production of eggs and (2) it was assumed that the new crop of corn had no effect on prices of corn until November, and that the relationships between prices of corn and supplies of feed, animal units fed, and prices of livestock that were found to prevail for the period November-May were equally applicable to the period June-October. In actuality, both the old supply of corn and the estimate of the new supplies of feed affect prices

[4] When the prices are lagged and weighted in the manner indicated by equation (8) on page 51.

in the latter part of the marketing year. The first simplification would be unsatisfactory in the study of alternative support programs for livestock, but probably does no great damage in the study of support programs for corn. The second would be undesirable if short-term relationships were being analyzed. In the study for which this model was developed we mainly were concerned with aggregates over a 25-year period.

The following sequence was assumed in analyzing year-to-year changes in the several variables involved: (1) prices of livestock for November to May are determined by the number of animal units fed on farms in the preceding year and current disposable income from November to May. (2) Prices of corn for November to May are determined by the level of animal units in the preceding year, new crop supplies (production plus stocks) of feed and prices of livestock from step 1. (3) Animal units fed are determined by new crop supplies of feed and prices of corn and livestock for the calendar year beginning in the same year that the October to September corn-marketing year begins. Prices for the calendar year were determined by weighting prices for November to May and June to October by the proportion of the sales for the calendar year obtained from each period. (4) Prices of livestock from June to October are determined by the level of animal units from step 3 and current disposable income for June to October. (5) Prices of corn from June to October are determined by the level of animal units from step 3, the level of prices of livestock from step 4, and the supplies of feed used in step 2.

All of the analyses were based on first differences of logarithms, so that the results are given in the form of percentage changes from the preceding year. Actual levels for any given year were obtained by applying these changes to the computed level in the preceding year. By this method, the study was continued year by year for as long as desired.

In the analysis of the effects of alternative loan programs for corn on the feed-livestock economy, the following general approach was used: (1) Certain assumptions were made regarding year-to-year changes in the exogenous variables of feed production and disposable income. (2) The effects of these on prices of corn and livestock, on production of livestock and on total returns to farmers, within the assumed loan program framework, were measured on a year-to-year basis. (3) Results for the alternative loan programs and those arising without a loan program were compared, both by years and in total for a number of years.

This method appears preferable to one in which results for specified loan programs are compared with actual prices for a given period. Many factors other than those allowed for in the model affect actual prices, so that the differences between results under a given loan program and actual prices reflect not only those due to the loan program as such, but also the effects of all factors not allowed for in the model. Under the

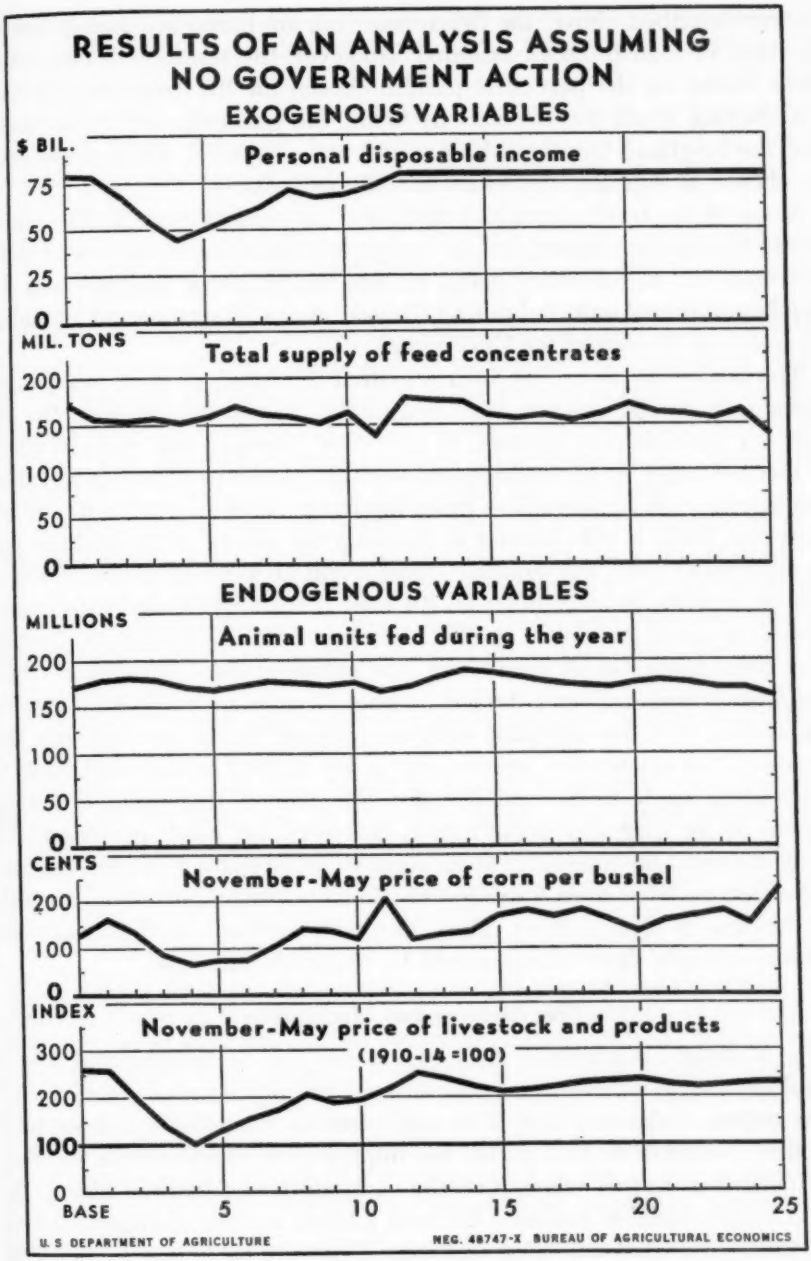
RESULTS OF AN ANALYSIS ASSUMING NO GOVERNMENT ACTION
EXOGENOUS VARIABLES
$ BIL.
Personal disposable income
75
50
25
0
MIL. TONS
Total supply of feed concentrates
200
150
100
50
0
ENDOGENOUS VARIABLES
MILLIONS
Animal units fed during the year
200
150
100
50
0
CENTS
November-May price of corn per bushel
200
100
0
INDEX
November-May price of livestock and products
(1910-14 =100)
300
200
100
0
BASE
5
10
15
20
25
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FIGURE 2

system described above, the differences that are found are mainly due to the type of loan program assumed. However, the results will depend to some extent on the particular pattern chosen for the exogenous factors, the starting levels for the various items, the particular equations used, and the length of time for which results are computed. All of these must be chosen as logically and as realistically as possible.

Some of the results from this study are shown in Figure 2. This chart shows the levels assumed for the exogenous variables in one set of computations and the resulting prices of corn and livestock products and the number of animal units fed during the year over a 25-year period assuming no action on the part of the Government.

The author believes that such a system of equations is of most value when used in the manner described above. Under this method, the exogenous variables are assumed to vary in a specified way and the effect of these changes on the endogenous variables is measured under specified conditions, such as alternative price support or acreage control programs. However, there is also interest in knowing the nature of the endogenous mechanism as such. For example, there might be more economic justification for a price support program for corn if the endogenous mechanism tended to generate violent oscillations than if no oscillations or fluctuations were generated by the system. The nature of the endogenous system could be determined for a limited number of years by a direct solution of the system, but the algebraic solution outlined below will indicate the nature of the mechanism *forever*, that is, for as long as the mechanism is believed to apply to the real situation. As given in this paper, the steps appear to be long and complicated. However, for many problems, the analysis would be completed at an early stage. Moreover, several alternative solutions have been indicated to illustrate particular methods which are helpful in certain cases. Thus, the steps outlined in this paper are double or triple those which would be required ordinarily.

The Endogenous Mechanism

By a slight modification, these equations can be transformed into a simultaneous linear difference equation system with constant coefficients.[5] This system is shown below. It is equivalent to the set of equations used for the November to May period but implies an identical set for the June to September period, whereas in the computations described above, the same supply variable was used for both periods and the change in animal units was computed only once each year. Equation (6) below is equivalent

[5] See Baumol, *op. cit.*, p. 146-147. This system is linear when all variables are expressed in logarithms. It will be noted that the 3-equation form is used in the following computations.

to equation (5) on page 47, equation (7) is equivalent to equation (1), and equation (8) is equivalent to equation (2). A time interval of approximately 6 months is assumed in this system, that is, t + 1 refers to the date 6 months after t. The coefficients within the parentheses in the equation for animal units represent the weights which were applied to derive calendar year average prices for corn and livestock products.

$$(6)\quad L_{t+2} - L_{t+1} = -.00190 - 1.17\,(A_{t+2} - A_t) + 1.45\,(I_{t+2} - I_{t+1})$$

$$(7)\quad C_{t+2} - C_{t+1} = .00373 - 2.36\,(S_{t+2} - S_{t+1}) + 1.94\,(A_{t+2} - A_t) + 1.13\,(L_{t+2} - L_{t+1})$$

$$(8)\quad A_{t+2} - A_{t+1} = -.092 + .214\,(S_{t+2} - S_{t+1}) - .185\,(.45C_{t+1} + .22C_{t+2} + .33C_{t+3}) + .207\,(.42L_{t+1} + .16L_{t+2} + .42L_{t+3})$$

Mathematical analysis permits an examination of the mechanism of the endogenous part of the system and, in particular, the prediction of the time path which the system would take were it not subject to exogenous influences. This is done by finding the roots of an equation based on the coefficients of the endogenous variables and formed in the manner described below. The nature of the roots imply the following:[6]

1. If some of the roots are complex, the system may fluctuate more or less cyclically, but the length of the cycle will vary from case to case.

2. If some of the roots are negative, the system may involve one-period oscillations which alternate between "high" and "low" values for successive periods. If the time path is fluctuating around zero, the sign will change each period.

3. If all of the roots are real and positive (or zero), neither fluctuations nor oscillations will be involved.

4. If any of the roots are greater than unity in absolute value, the time paths of the variables will be explosive, going up or down without limit or involving fluctuations or oscillations of ever increasing amplitude.

5. If none of the roots are greater than unity in absolute value, the movements of the system will damp down to equilibrium.

In this connection, Baumol gives the following warning:

> "In applying this result the economist must exercise extreme caution in interpretation. Above all he should not place *too* much confidence in the system's predictions as to what will happen eventually. 'Eventually' may turn out to be a very long time away; indeed, it may be so far away that before the foreseen outcome materializes, changing conditions may render our original difference-equation completely inapplicable to the real world. We may thus legitimately describe trends and tendencies of the system, but we must not be surprised if 'exogenous causes' prevent their fruition, much as the advent of birth control and technological advance upset the classical population predictions."[7]

Obtaining the actual roots of the equation is one means of indicating how long it may take an explosive system to actually explode.

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[6] *Ibid.*, pp. 196-202.
[7] *Ibid.*, p. 198.

Forming the Determinantal Equation

The first step in the mathematical analysis involves setting the coefficients of the terms involving exogenous variables equal to zero, to eliminate their influence. The constant terms can also be eliminated, since generally these will not influence the nature of the time path of the system.[8] The terms in the equations are rearranged so that all non-zero terms are on the left-hand side and like variables follow the same order in each equation. The system for the feed-livestock economy then takes the following form:

$$L_{t+3} - L_{t+1} + 1.17\,(A_{t+2} - A_t) = 0 \tag{6a}$$

$$-1.13\,(L_{t+3} - L_{t+1}) - 1.94\,(A_{t+2} - A_t) + C_{t+3} - C_{t+1} = 0 \tag{7a}$$

$$-.207\,(.42L_{t+1} + .16L_{t+2} + .42L_{t+3}) + A_{t+3} - A_{t+1} + .185\,(.45C_{t+1} + .22C_{t+2} + .33C_{t+3}) = 0 \tag{8a}$$

The following substitutions are made and a determinant formed in the manner shown:

x^3 for a variable in $t + 3$
x^2 for a variable in $t + 2$
x for a variable in $t + 1$
1 for a variable in t

$$\Delta(x) = \begin{vmatrix} x^3 - x & 1.17x^2 - 1.17 & 0 \\ -1.13x^3 + 1.13x & -1.94x^2 + 1.94 & x^3 - x \\ -.0869x^3 - .0331x^2 - .0869x & x^3 - x & .0610x^3 + .0407x^2 + .0832x \end{vmatrix}$$

In this determinant, x represents the operator E which is defined by

$$E^n Y_t = Y_{t+n}$$

where Y is any variable and Y_t is its value at time t.[9]

The determinantal equation is obtained by setting this determinant equal to zero and solving for the polynomial equation in X.

The following equation is obtained:

$$-x^9 - .1394x^8 + 2.9361x^7 + .1257x^6 - 2.8722x^5 + .1668x^4 + .9361x^3 - .1531x^2 = 0 \tag{9}$$

To simplify the equation, we divide by $-x^2$, giving

$$f(x) = x^7 + .1394x^6 - 2.9361x^5 - .1257x^4 + 2.8722x^3 - .1668x^2 - .9361x + .1531 = 0 \tag{9a}$$

This equation will have 7 roots, since the degree of the equation is equal to 7.

Obtaining the General Characteristics of the Roots of the Equation

1. To find out how many of the roots are real and how many of these

[8] But cf. *Ibid.*, pp. 173-176, 179-181 and 202-204.

[9] For a discussion of the meaning and use of this operator, see A. P. Samuelson, *Foundations of Economic Analysis*, Cambridge, Mass., 1947, Appendix B.

are positive and how many negative, Sturm's method may be employed.[10] The following computations are involved in applying this method to the model of the feed-livestock economy:

The first derivative of f(x) is

$$f'(x) = 7x^6 + .8364x^5 - 14.6805x^4 - .5028x^3 + 8.6166x^2 - .3336x - .9361. \tag{10}$$

Sturm's method is applied as follows:

a. $$\frac{f(x)}{f'(x)} = .1429x + .002843 - f_2,$$

where the remainder

$$f_2 = .8359x^5 + .0121x^4 - 1.6423x^3 + .1436x^2 + .8014x - .1558.$$

b. $$\frac{f'(x)}{f_2} = 8.3742x + .8794 - f_3,$$

where the remainder

$$f_3 = .9382x^4 + .2611x^3 - 1.7792x^2 - .2663x + .7991.$$

c. $$\frac{f_2}{f_3} = .8910x - .2350 - f_4,$$

where

$$f_4 = -.0044x^3 + .0372x^2 - .0268x - .0320.$$

d. $$\frac{f_3}{f_4} = -213.23x - 1862.11 - f_5,$$

where

$$f_5 = -61.7767x^3 + 56.9942x + 58.7884.$$

e. $$\frac{f_4}{f_5} = .00007122x - .0005358 - f_6,$$

where

$$f_6 = .0005x + .0005.$$

f. $$\frac{f_5}{f_6} = -123{,}553x + 237{,}542 - f_7,$$

where

$$f_7 = 59.9825.$$

g. Before proceeding to the next step, it is convenient to summarize these equations as follows:

[10] See L. E. Dickson, *First Course in the Theory of Equations*, New York, 1922, pp. 75-76. See the rest of Chap. V or the equivalent discussion in any text in the theory of equations for the derivation, some simplification in the method, the procedure in the case of multiple roots, and Descartes' and Budan's theorems which can in some cases be very helpful.

$$
\begin{aligned}
f &= x^7+.1394x^6-2.9361x^5- .1257x^4+2.8722x^3- .1668x^2- .9361x+ .1531\\
f' &= 7x^6+ .8364x^5-14.6805x^4- .5028x^3+ 8.6166x^2- .3336x- .9361\\
f_2 &= .8359x^5+ .0121x^4-1.6423x^3+ .1436x^2+ .8014x- .1558\\
f_3 &= .9382x^4+ .2611x^3- 1.7792x^2- .2663x+ .7991\\
f_4 &= - .0044x^3+ .0372x^2- .0268x- .0320\\
f_5 &= -61.7767x^2+56.9942x+58.7884\\
f_6 &= .0005x+ .0005\\
f_7 &= 59.9825
\end{aligned}
$$

Sturm's theorem may be stated in the following way: If a is any real number, we may compute the sequence $f(a)$, $f'(a)$, $f_2(a)$, . . . , $f_t(a)$ of real numbers and count the number of variations of sign in the non-zero members of this sequence. Let us designate this number by $V(a)$. Now, let a and b be real numbers such that $f(a) \neq 0$, $f(b) \neq 0$, $a < b$. Then $V(a) - V(b)$ is the number of distinct real roots between a and b. When $f(x)$ has multiple roots, our count ignores the multiplicity.

h. In determining the nature of the endogenous mechanism, we are mainly concerned with the number of negative and positive roots and hence check the variation in signs for $-\infty$, 0, and ∞. These are as follows:

Value of x	*Signs*	*Variations*
$-\infty$	$-+-+++--+$	5
0	$+--+-+++$	4
∞	$++++--++$	2

The signs for minus and plus infinity will be determined by the sign of the highest power of x, since as x increases in value the terms with a lower power will be small in relation to the term with highest power. When x equals minus infinity, the sign will be equal to the sign of the coefficient of the term with the highest power when the power is even and will equal the negative of this sign when the power is odd. When x equals plus infinity, the sign will equal the sign of the coefficient of the term with the highest power in all cases. When x equals zero, the sign will equal the sign of the constant term in each equation.

According to Sturm's theorem, we have 5 − 4 or 1 root between minus infinity and zero and 4 − 2 or 2 roots between zero and plus infinity. Since there are 7 roots in the determinantal equation, we must have two pairs of complex roots. (Complex roots always come in pairs.) *Applying the criteria given previously, the system may involve fluctuations and may involve one-period oscillations.*

i. As an alternative, we could have assumed that f_6 was equal to zero. If the remainder at some stage is almost equal to zero, we can assume that it is zero, since a slight change in f(x) could make it zero, so that the non-zero remainder might be ascribed to errors in the data.

If after some term we get a zero remainder, then the system has multiple roots, which are the roots of the last non-zero remainder. Generally, this means that we have to treat this last non-zero remainder ex-

actly like the original equation, subjecting it to Sturm's test. In this case, we can see immediately that f_5 will have positive and negative roots. Under this assumption, the system may involve one-period oscillations.

2. The next step involves a determination of whether or not some of the roots are greater than unity in absolute value.

In this particular analysis, a short-cut method may be applied as a preliminary step. We know that the multiple roots are contained in f_5, since f_6 was (approximately) equal to zero. As f_5 is a quadratic, we can solve for the roots by the usual formula, which states that the roots of an equation of the type

$$y = ax^2 + bx + c = 0$$

are given by

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}.$$

The roots of f_5, as given by this formula, are 1.5404 and $-$ .6178. *If either root exceeds unity in absolute value, the time path of the system is explosive.* Since in this instance the positive root exceeds unity, *the values of our variables must constantly increase beyond any preassigned limits.* Since this root is only moderately greater than unity, however, we know that it will take a long time for the system to explode, *based on this root alone,* and this tendency may be offset by fluctuations in the exogenous variables. Of course, some of the other roots of the equation may have a larger absolute value.

If we were interested only in the general character of the time-path of the endogenous mechanism, this would complete the analysis.

Other Methods Which Might Be Required in Obtaining the General Characteristics of the Roots of the Equation

1. If the roots of f_5 had been less than unity, we would have needed to check the other 3 roots to see whether any of these exceeded unity.[11] The following steps could have been used:

a. Form the product $\Pi(x - r_1)$, where the r_1 are the roots of the last non-zero remainder.

b. Multiply this product by $\Pi(x - r'_1)$, where the r'_1 equal the r_1 except that none are repeated.

c. Take the resulting product and divide f(x) by it. The remaining part of f(x) contains those and only those roots still not known.

Applying this method to our model, we obtain the following results:

a. Since the multiple roots obtained from the quadratic f_5 are distinct,

[11] Since each of the roots obtained from the above is a multiple root, the two multiple roots together equal 4 roots, leaving 3 of the 7 roots still to be determined.

$\Pi(x - r_i)\,\Pi(x - r'_i) = [\Pi(x - r_i)]^2 = f^2_5.$

$f^2_5 = 3816.36x^4 - 7041.83x^3 - 4015.17x^2 + 6701.20x + 3456.08.$

b. $\dfrac{f(x)}{f^2_5} = .0002620x^3 + .0005200x^2 + .0004658x + .0009136 = 0$

with a remainder of $6.7858x^3 - 1.4171x^2 - 8.6681x - 3.0044$. This remainder is small in relation to the size of the divisor and is assumed to be zero except for rounding errors since f_6 was assumed to be zero.

We know that the cubic equation given in (b) contains the remaining roots.

c. The following theorem may be employed to determine whether or not the roots of this equation are equal to or less than unity in absolute value:

The roots of the polynomial

$$f(x) = a_0x^n + a_1x^{n-1} + \ldots + a_{n-1}x + a_n = 0$$

are all no greater than unity in absolute value if and only if the n determinants

$$D_i = \begin{vmatrix} a_0 & 0 & \cdots & 0 & a_n & a_{n-1} & \cdots & a_{n-i+1} \\ a_1 & a_0 & \cdots & 0 & 0 & a_n & \cdots & a_{n-i+2} \\ \cdot & \cdot & & \cdot & \cdot & \cdot & & \cdot \\ \cdot & \cdot & & \cdot & \cdot & \cdot & & \cdot \\ \cdot & \cdot & & \cdot & \cdot & \cdot & & \cdot \\ a_{i-1} & a_{i-2} & & a_0 & 0 & 0 & \cdots & a_n \\ \cdot & \cdot & & \cdot & \cdot & \cdot & & \cdot \\ a_n & 0 & \cdots & 0 & a_0 & a_1 & \cdots & a_{i-1} \\ a_{n-1} & a_n & \cdots & 0 & 0 & a_0 & \cdots & a_{i-2} \\ \cdot & \cdot & & \cdot & \cdot & \cdot & & \cdot \\ \cdot & \cdot & & \cdot & \cdot & \cdot & & \cdot \\ \cdot & \cdot & & \cdot & \cdot & \cdot & & \cdot \\ a_{n-i+1} & a_{n-i+2} & & a_n & 0 & 0 & \cdots & a_0 \end{vmatrix},$$

where $i = 1, 2, \ldots, n$, all be greater than zero.[12]

[12] See John S. Chipman, "The Multi-Sector Multiplier," *Econometrica*, 1950, or his *The Theory of Inter-sectorial Money Flows and Income Formation*, Johns Hopkins Univ. Studies in Historical and Political Science 68:2, Baltimore, 1951, pp. 119-120, for references. See also Samuelson, *Op. Cit.*, pp. 427-437. For methods to be used in the computation of the determinants, see R. A. Frazer, W. J. Duncan, and A. R. Collar, *Elementary Matrices*, New York, 1946, pp. 106-108.

In analyzing a cubic equation, we are interested in the following determinants:

$$D_1 = \begin{vmatrix} a_0 & a_3 \\ a_3 & a_0 \end{vmatrix}$$

$$D_2 = \begin{vmatrix} a_0 & 0 & a_3 & a_2 \\ a_1 & a_0 & 0 & a_3 \\ a_3 & 0 & a_0 & a_1 \\ a_2 & a_3 & 0 & a_0 \end{vmatrix}$$

$$D_3 = \begin{vmatrix} a_0 & 0 & 0 & a_3 & a_2 & a_1 \\ a_1 & a_0 & 0 & 0 & a_3 & a_2 \\ a_2 & a_1 & a_0 & 0 & 0 & a_3 \\ a_3 & 0 & 0 & a_0 & a_1 & a_2 \\ a_2 & a_3 & 0 & 0 & a_0 & a_1 \\ a_1 & a_2 & a_3 & 0 & 0 & a_0 \end{vmatrix}.$$

d. The higher order determinants may be computed by means of the following scheme. The original determinant, D, is written in the upper left-hand section. The remaining computations are indicated below. The scheme is written out for a 4 x 4 determinant, but the extension to a higher order determinant is obvious.

$$\begin{array}{cccc|ccc}
a_{11} & a_{12} & a_{13} & a_{14} & \frac{-a_{12}}{a_{11}} & \frac{-a_{13}}{a_{11}} & \frac{-a_{14}}{a_{11}} \\
a_{21} & a_{22} & a_{23} & a_{24} & 1 & 0 & 0 \\
a_{31} & a_{32} & a_{33} & a_{34} & 0 & 1 & 0 \\
a_{41} & a_{42} & a_{43} & a_{44} & 0 & 0 & 1 \\
\hline
 & b_{11} & b_{12} & b_{13} & \frac{-b_{12}}{b_{11}} & \frac{-b_{12}}{b_{11}} & \\
 & b_{21} & b_{22} & b_{23} & 1 & 0 & \\
 & b_{31} & b_{32} & b_{33} & 0 & 1 & \\
\hline
 & & c_{11} & c_{12} & \frac{-c_{12}}{c_{11}} & & \\
 & & c_{21} & c_{22} & 1 & & \\
\hline
 & & & d_{11} & & &
\end{array}$$

where $b_{11} = a_{21}(-a_{12}/a_{11}) + a_{22}$ (i.e. the sum of the elements of the *second* row in the upper left-hand section times the elements of the *first* column of the upper right hand section.)

$b_{12} = a_{21}(-a_{13}/a_{11}) + a_{23}$ (i.e. the sum of the elements of the *second* row in the upper left-hand section times the elements of the *second* column of the upper right-hand section), etc.

$b_{21} = a_{31}(-a_{12}/a_{11}) + a_{32}$ (i.e. the sum of the elements of the *third* row in the upper left-hand section times the elements of the *first* column of the upper right-hand section), etc.

The c_{ij} are determined from the b_{ij} in the same manner as the b_{ij} are determined from the a_{ij}, etc.

$D = a_{11}\, b_{11}\, c_{11}\, d_{11}$

C. The following results are obtained when this method is applied to the cubic equation obtained in Step b:

First, we divide through by the coefficient of x^3, which gives $x^3 + 1.9846x^2 + 1.7780x + 3.4872 = 0$. Then, $a_0 = 1$, $a_1 = 1.9846$, $a_2 = 1.7780$, $a_3 = 3.4872$.

$$D_1 = \begin{vmatrix} 1 & 3.4872 \\ 3.4872 & 1 \end{vmatrix} = -11.1606.$$

Thus it is immediately evident that the cubic equation contains one or more roots which are equal to or greater than unity.

2. Since we are interested in the roots of a cubic equation, these can be obtained by direct methods.[13] The following roots were obtained:

$$x = .8723,\ -1.4284 + 1.1393i,\ -1.4284 - 1.1393i.$$

The last two are conjugate imaginary roots.

The relative magnitude of the roots for a higher order equation could have been found by repeated application of Sturm's theorem (see p. 54) or by other methods.

Conclusions

The roots of the determinantal equation for the system of simultaneous difference equations describing the feed-livestock economy were found to be 1.5404, −.6178, .8723, −1.4284 + 1.1393i and −1.4284 − 1.1393i, where the first two are multiple roots, giving 7 roots in all.[14] As the roots are both real and imaginary (or complex)—some positive, some negative, and some greater than unity in absolute value—we can make the following observations: (1) Since the imaginary roots have a fairly large absolute

[13] See any standard algebra text.

[14] It should be noted that by applying Sturm's theorem we obtained 1 negative real root, 2 positive real roots and 2 pairs of complex roots. When we assume that f_6 is equal to zero and solve for the roots directly, we obtain 2 negative real roots, 3 positive real roots, and 1 pair of complex roots.

value, the system probably will involve more or less cyclical fluctuations. (2) Since these roots are greater than unity, the fluctuations will tend to increase in amplitude and to ultimately explode. (3) Since none of the roots is very much greater than unity, any explosive tendencies of the system will manifest themselves slowly and the system probably will become inapplicable to the facts well before any such explosive tendencies become apparent to the observer.[15] These conclusions are consistent with the results of direct analyses similar to those shown in Figure 2.

Appendix

Some readers may find it helpful to see such an analysis applied to an extremely simple system with varying coefficients. The simplest simultaneous system is a 2-equation "cobweb" model of the following sort:

Demand equation: $p_t = b\,q_t$
Supply equation: $q_{t+1} = B\,p_t$

Rewriting these equations in the standard form gives the following:

$$p_t - b\,q_t = 0$$
$$-B\,p_t + q_{t+1} = 0$$

Substituting powers of X for the variables with specified time lags and forming a determinant gives the following:

$$\Delta X = \begin{vmatrix} X & -bX \\ -BX & X^2 \end{vmatrix}.$$

Solution of this determinant gives the determinantal equation

$$X^2 - bBX^2 = 0,$$

which can be simplified to

$$X - bB = 0.$$

The root of this equation is bB.

Research in the Bureau of Agricultural Economics indicates that for most agricultural commodities analyses run in terms of logarithms with prices at the farm level will yield coefficients for b between -0.7 and -3.5 and for B between 0.1 and 0.5.[16] Table 1 shows data for the first 5 years for price and quantity for systems of equations having coefficients of specified size within these ranges. Since bB is always negative, one-

[15] In analyses of this type, the standard errors of the regression coefficients are disregarded of necessity. Thus, the significance levels of the final results are unspecified, and the results should be used with caution.

[16] See Karl A. Fox, Factors Affecting Farm Income, Farm Prices, and Food Consumption, *Agricultural Economics Research*, July, 1951, for typical b coefficients.

TABLE 1. SUCCESSIVE VALUES OF PRICE AND QUANTITY FOR A 2-EQUATION SIMULTANEOUS LINEAR DIFFERENCE SYSTEM WITH SPECIFIED COEFFICIENTS[1]

Time period	Coefficients															
	b = −.7 B = .1 bB = −.07		b = −.7 B = .5 bB = −.35		b = −3.5 B = .1 bB = −.35		b = −2.0 B = .2 bB = −.40		b = −2.0 B = .5 bB = −1.0		b = −2.2 B = .5 bB = −1.10		b = −2.5 B = .5 bB = −1.25		b = −3.5 B = .5 bB = −1.75	
	q_t	p_t	q_t	p_t	q_t	p_t	q_t	p_t	q_t	p_t	q_t	p_t	q_t	p_t	q_t	p_t
1	1.00	− .70	1.00	− .70	1.00	−3.50	1.00	−2.00	1.00	−2.00	1.00	−2.20	1.00	−2.50	1.00	−3.50
2	− .07	.05	− .35	.24	− .35	1.22	− .40	.80	−1.00	2.00	−1.10	2.42	−1.25	3.12	−1.75	6.12
3	.00	− .00	.12	− .09	.12	− .43	.16	− .32	1.00	−2.00	1.21	−2.66	1.56	−3.91	3.06	−10.72
4			− .04	.03	− .04	.15	− .06	.13	−1.00	2.00	−1.33	2.93	−1.95	4.88	−5.36	18.76
5			.02	− .01	.02	− .05	.03	− .05	1.00	−2.00	1.46	−3.22	2.44	−6.10	9.38	−32.83

[1] Computed from unrounded data. P_t and q_t are expressed in terms of deviations from some mean or normal value.

period oscillations occur for each set. When bB is less than 1, the oscillations damp down to zero; when bB is greater than 1, the oscillations explode; when bB equals 1, the oscillations are of constant magnitude.

Since for the equations given here, b is a price flexibility while B is the elasticity of supply (when all variables are expressed in logarithms), the case in which $b = -2$ and $B = 0.5$ is equivalent to one in which the elasticity of demand is equal to the elasticity of supply. In such cases, the oscillations are of constant magnitude.

RELATIVE COSTS AND BENEFITS OF LAND RECLAMATION IN THE HUMID SOUTHEAST AND THE SEMIARID WEST*

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A GROWING population[1] with improved living standards, both here and abroad, increases the demand for food and fiber and the land to produce them. Consequently, questions of the most economical ways and means of obtaining these products become increasingly urgent. In the final analysis, the justification for large-scale governmental land policies and programs such as soil conservation and irrigation rests largely upon the need to maintain and to increase the long-run supply of agricultural products. Both the individual and aggregate welfare of the people of the United States are dependent on how efficiently the increased supply is obtained.

Most of the naturally highly fertile lands with a favorable climate such as those of the midwestern Corn Belt are already in use. Although the production from such lands can and probably will be increased by improved agricultural practices, yields are already high. Elsewhere in the United States, the lands suitable for agriculture are naturally deficient in either general fertility or climate, or both. Most lands east and south of the Corn Belt are equally or more favorably situated climatically. Characteristically, they have as much or more rainfall, as high or higher temperature, and equal or longer growing seasons. The soils of such a climatic environment developing under mixed coniferous-hardwood forest are typically more acid, lighter colored, more leached, and less fertile than the dark-colored soils of the Corn Belt. Contrariwise, most lands generally west of the Corn Belt are naturally fertile[2] but are climatically deficient, chiefly in rainfall which decreases to negligible amounts over large areas.

To the extent that increased agricultural production[3] must be obtained

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* The views expressed here are those of the author, and do not necessarily reflect those of the U. S. Department of Agriculture.

[1] The population of the United States has increased about 100 per cent in the last fifty years, from about 76 million in 1900 to more than 150 million in 1950. It increased from about 130 to 150 million in the 1940-50 period, and more than 2 million people are being added to the population each year. Population increases for the world as a whole are variously estimated at about 20 to 25 million per year.

[2] This generalization has exceptions. For example, the contents of organic matter and nitrogen generally decrease west and south with decreasing rainfall and increasing temperature from the maximum of the dark-colored soils of the Corn Belt.

[3] There are indications that presently developed land resources are more than adequate to meet foreseeable increased demands for agricultural products. In an address at the Ninth Annual Institute of Conservation, Nutrition, and Health at Chicago, Illinois, July 1950, J. F. Timmons of Iowa State College presented data on

from less favorable land resources outside the middle-western optimum, the problem in both physical and economic terms is dominantly one of adding capital in the form of fertility to the soils of the East and South and water to those of the West. In conjunction with the other necessary productive agents, labor and management, the most efficient agricultural production will be obtained from those lands which minimize these alternative capital inputs. Because of the different kinds and amounts of the inputs of the productive factors, as well as the resulting outputs of agricultural products, meaningful evaluations can be best made in economic terms. It is the purpose of this paper to compare the relative costs and benefits from investment in irrigation of arid and semiarid western soils with those from soil-improvement practices in the humid southeast. Specifically, the probable differences in resource efficiencies between the Columbia Basin Project in Central Washington and an eastern alternative in the Piedmont Plateau physiographic province are compared.

The principal sources of information for the Columbia Basin Area are (1) A soil survey[4] made in 1929, (2) a joint Federal and State study[5] made in advance of impending irrigation development, (3) Development Report No. 2 by the Bureau of Reclamation,[6] and (4) House Document 172, 79th Congress.[7] In a general way, the conditions in the temperate-arid and semiarid areas throughout Oregon, Nevada, Idaho, Utah, Colorado, and Wyoming are comparable to the Columbia Basin of Washington, and the general analyses and conclusions of this paper apply.

The principal source of information for the Piedmont Plateau area is the recently completed Soil Survey of Mecklenburg county, Virginia.[8] The principal findings and the accompanying interpretations and recommendations are most applicable to the soil, land use, and management condi-

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population, cropland, and agricultural production from 1870 to 1950 which indicate agricultural production is increasing even faster than population. Since 1920, these increases in population and agricultural production have been supported by about the same total area of cropland, approximately 400 million acres. During the 1940's, the population increase was 15 per cent, or 20 million people, and the increase in agricultural production approximately 25 per cent. These rates of increase were approximately double those of the 1930's, 7 per cent for population and 12 per cent for agricultural production.

[4] A. T. Strahorn *et al., Soil Survey (Reconnaissance) of the Columbia Basin Area,* Washington, Series 1929, No. 28, Bureau of Chemistry and Soils, United States Department of Agriculture.

[5] *Soil, Water, and Crop Management Investigations in the Columbia Basin Project,* Bulletin 520, Bureau of Plant Industry, Soils and Agricultural Engineering and Washington Agricultural Experiment Station, November 1950.

[6] *Columbia Basin Project, opportunities, responsibilities, and needs in development,* Development Report No. 2, U.S.D.I., Bureau of Reclamation, Ephrata, Washington, February 1949.

[7] House Document 172, 79th Congress, 1st Session, Oct. 30, 1944.

[8] Report by R. C. Jurney, and E. F. Henry, "Soil Survey of Mecklenburg County, Virginia," Division of Soil Survey, BPISAE, USDA, and Virginia Agricultural Experiment Station cooperating (in manuscript form), Beltsville, Md.

tions in Mecklenburg County and along the Virginia, North Carolina boundary.

With reservations principally in degree and not in kind, the findings are applicable throughout the Cecil-Appling Soil association area which dominates the entire Piedmont Plateau from Alabama to Maryland. With somewhat further reservations, the findings apply to the entire southeastern portion of the United States because of the general similarity of land conditions. Kellogg and Barnes[9] have conservatively estimated that some 40 million acres are potentially available for more intensive agricultural production in the southeast alone if and when the demand for their products arises.

The Nature of the Land Resources Involved

The Columbia Basin Project of Central Washington

Prior to development for small-grain dry farming or grazing, the Columbia Basin Project area of about 2.5 million acres was a treeless plain covered with sagebrush or sparse bunchgrasses. The climate is arid-temperate. The annual rainfall varies from 6 inches in the southwest to about 10 inches in the northeast. It falls almost entirely during winter and spring. Summer rainfall is negligible. The mean annual temperatures vary from 50° to 53°F. The average frost-free interval in the 1941-49 period, as determined by 26 Bureau of Reclamation stations, is about 170 days. It varied from 206 days on the Central Wahluke Slope to 123 days south of Frenchman Hills. The basin is generally underlain at variable depths by Tertiary basalt. In places, the basalt outcrops and forms "scabland." To the west, the principal soils such as the Ephrata, Sagemoor, and Burke series are members of the Sierozem great soil group. Characteristically, they are sandy throughout, and they are covered with sagebrush vegetation. To the eastward on a line generally east of Pasco northward through Wheeler to Adrian, variable amounts of loess overlie the sandy or basaltic materials and generally give rise to somewhat finer-textured soils predominantly in the Ritzville series and the Brown great soil group. These soils are more fertile, receive slightly more rainfall, and are generally covered with bunchgrasses.

Physically, the greatest variations in the different soils are in the silt and sand contents. Clay contents generally range from 2 to 7 percent and vary little with increasing soil depth. As a consequence of such uniform textural profiles, moisture-holding capacities are very low, and measurements indicate available moisture-holding capacities are about 1 to 2 inches per foot of soil. Such soils generally tend to be well aerated, well drained, easily tilled, and warmed rapidly in the spring, but they require

[9] *Land Problems and Policies*, edited by J. F. Timmons and W. G. Murray, Iowa State College Press, Ames, 1950.

more frequent and lighter irrigations with larger heads and shorter runs than fine-textured soils.

As a consequence of scanty vegetation in the arid climate, the soils are low in organic matter and nitrogen. The organic matter content of the surface soil is generally less than one per cent, and it falls off rapidly with increasing soil depth. Total nitrogen contents are about .03 to .05 per cent in the surface soils. Soil reaction generally varies from slightly acid to moderately alkaline.

Fertilizer trials on virgin soils indicate that nitrogen is the chief plant nutrient limiting non-leguminous crops following irrigation. Indications are that 120 pounds of nitrogen on potatoes and 160 pounds per acre on corn are required to economically maximize yields. Phosphorus and potassium appear to be adequate now, but their use may become general after a period of years, especially phosphorus, for crops like alfalfa which have high mineral requirements. Responses to sulphur by some leguminous crops on some soils have been obtained. Among the minor elements, responses to zinc sprays have been obtained on some soil types. Locally, excess soluble salts and restricted drainage are a problem and may become more so as increasing amounts of irrigation water are applied.

Mecklenburg County, Virginia

Mecklenburg County is located on the eastern edge of the Piedmont Plateau along the Virginia, North Carolina boundary. At the time of settlement in colonial days, it was densely covered with mixed hardwood-coniferous forest.

The climate is humid-temperate without a distinct dry season. Summers are warm. The mean annual rainfall of 42.25 inches, as measured at Clarksville, is evenly distributed throughout the year with an average of more than 4 inches per month in June, July, and August. The average annual temperature is about 58°F., and the frost-free period averages 203 days.

The soils are predominantly members of the Red-Yellow Podzolic great soil group. Members of the Cecil and Appling series occupy almost 40 per cent of the county. These two series have light-colored sandy loam surface soils overlying reddish firm clay subsoils. The two series are largely differentiated on the basis of the degree of reddish color in the subsoil. The parent materials are coarse-textured granite, gneiss, or schist. Partly because of the sandy surface layer, the soils are well adapted to tobacco. The Cecil-Appling Soil Association area dominates the eastern portion of the county. In the western portions of the county, the parent rocks are fine-textured schists and slates. Weathering of these rocks has produced light-colored silty surface soils overlying reddish firm clay subsoils. The predominant soils are members of the Georgeville and Herndon

series. Except for the siltier surface soils, these two series are analogous to the Cecil and Appling soils, respectively, and are similarly differentiated on the degree of reddish subsoil coloration. Although soils with a silty surface layer are less adapted to tobacco culture, they are well suited to general farming. Generalizing broadly, the soils of the county have the following characteristics: (1) good natural drainage, (2) slow to medium surface runoff, (3) medium internal drainage, (4) good to fair water-supplying capacity, (5) undulating (2-6 per cent) to rolling (6-12 per cent) slopes, (6) low to very low contents of organic matter, (7) very strong to strong acidity, (8) low to very low natural fertility, and (9) depth of more than 3 feet to loose weathered bedrock.

Estimated Costs of Economic Development

The Columbia Basin Project of Central Washington

The Columbia Basin area is virtually undeveloped sagebrush grazing land to the west and sparsely settled dryland wheat farms to the east. According to Development Report No. 2, the important elements in the project stuation are:

1. *Size of project.* Plans are being made for an irrigation system adequate for 1,029,500 acres (a gross area of 1,095,200 acres including non-irrigable areas) sufficient for 13,000 to 14,000 family-size farms. Assuming the entire 1,029,500 acres is eventually developed, the average-sized farm would be between 73.5 and 78 acres. For various reasons, only 484,195 net acres (518,386 acres gross) sufficient for 6,800 farms are scheduled for initial development. The remainder is either in: (1) Atomic Energy Commission restricted areas, (2) areas of marginal nature, or (3) withdrawals by present owners. It is hoped that eventually all 1,029,500 acres will be included.
2. *Meager development of project area.* The project area itself is meagerly developed, and no large urban or industrial areas in the immediate vicinity exist from which to draw support. Most of the accessory facilities such as houses, roads, schools, processing and marketing facilities, plus all such non-farm elements as teachers, doctors, craftsmen, banks and credit institutions, and the like, must be built or brought into the area.
3. *High cost of development.* Costs of development are high and are likely to remain so throughout the period of development. Report No. 2 uses 1948 prices as a basis for its estimates, and 1952 prices are as high or higher.
4. *Full-time mechanized farms proposed.* Most farms will be of sufficient acreage to support an average-sized family. These farms will require substantial investments in land leveling, farm-distribution systems for irrigation water, buildings, machinery, and livestock. They are expected to produce goods primarily for sale. Adequate roads, transportation systems, processing plants and marketing facilities, now largely non-existent, will be necessary for the economic success of these farms.
5. *Availability of lands for homesteading.* About 20 percent of the project area is acquired public land, and none of it will be open to homesteading.

Settlers not owning land will have to purchase farms and veterans have preference for federally owned farm units.

According to H. A. Parker, District Manager, the latest official Federal cost estimates for the Columbia Basin Project are[a]:

Irrigation facilities	$418,524,000
Power facilities	113,300,000
Joint facilities	165,300,000
Total	$697,124,000[b]

[a] Private communication, Aug. 3, 1951.
[b] Other self-liquidating projects totaling $17,976,000 bring this total to $715,100,000.

According to House Document 172, $1 million is to be allocated to Flood and Navigation Control, and the remaining joint costs are to be allocated 56 per cent to power and 44 per cent to irrigation facilities. Such apportionment revises the above figures as follows:

Irrigation facilities	$490,816,000
Power facilities	205,308,000
Flood and navigation control (non-reimbursable)	1,000,000
	$697,124,000

In addition to the Federal costs to bring water to the proposed individual farm boundaries, other costs will be necessary to the economic success of the individual farms. Together with the direct Federal costs, the following total irrigation development costs are reported in or can be derived from Development Report No. 2.

Item	*Total Cost*[a]	*Per Acre*	*Per Farm*
Federal Government	$490,816,000	$477	$35,059
Domestic water supply			
Individual basis @ $2500 per farm	35,000,000	34	2,500
Group basis @ $2100 per farm	(29,400,000)*	(29)*	(2,100)*
Farm Development @ 19,000 per farm	266,000,000	258	19,000
State Roads, 172 miles	8,836,000	9	617
County Roads, 3,066.56 miles[b]	28,023,430	27	2,002
Additional School Facilities[b]	34,801,840	34	2,486
	$863,477,270	$839	$61,664
Totals	$857,877,270	$834	$61,264

[a] Based on 14,000 farms (73.5 acres per farm), 1,029,500 acres, and 1948 prices.
[b] Fully adequate; minimum needs are estimated at one-half this amount.
* These figures not shown in first total.

Mecklenburg County, Virginia

Mecklenburg County occupies 665 square miles or 425,600 acres. Similarly, the 1950 agricultural census reported 4,034 farms occupying 350,748 acres or 82.4 per cent of the total area. The average number of acres per farm is 86.9 of which 33 acres, or 38 per cent, was improved land (crop-

land plus plowable pasture). In order of acreage, the principal crops in 1949 were: (1) corn, 25,806, (2) hay (total) 20,099 acres; (3) tobacco, 13,559 acres; (4) wheat, 4,630 acres; (5) cotton, 3,516 acres; (6) oats, 1,155 acres; and (7) barley, 553 acres. From the standpoint of gross value, tobacco is first in importance.

The population of the county in 1950 was 33,497. It is fairly evenly distributed and averages 50 people per square mile. The population of the three largest communities range in size from 501 in Boydton to 2,519 in Chase City. Two railroads, the Southern (with two branches) and the Seaboard Air Line serve all large and small communities. In addition, U. S. Highways 1, 15, and 58 traverse the county. Bus lines operate on all the major highways. Most farms are on or near an all-weather road. Churches average 5 miles apart, and adequate school facilities for both white and colored populations are present. Many farms have electricity and telephone service, and most of the remainder are within a quarter of a mile of such facilities. Local markets for agricultural products, as well as many small industries, are present in the small towns and villages in the county or in the large cities in adjacent counties.

Because of the above mentioned facilities, the major factors in the agricultural development of the county are land clearing, liming, fertilization, water-control practices, and the additional facilities to handle the increased output efficiently. A land-use survey made in 1944 indicated the following major land uses:

Land Use	*Acres*	*Per Cent*
Woodland	238,406	56.0
Cropland	136,212	32.1
Idle	34,896	8.2
Pasture	6,212	1.5
Brush	4,970	1.2
Farmyards, etc.	4,272	1.0
Totals	424,968	100.0

The above figures indicate that more than half of the county is essentially undeveloped agriculturally. Over half of the county is in woodland even though only about 73,500 acres are in the hilly classification. Table 1 summarizes the four principal classes of land in the county and their approximate present use based on estimates made during the soil survey. Also included in Table 1 is the maximum proposed land-use conversions and improvements believed feasible at the present time. As shown by Table 1, about 76 per cent of the land is now cropped or is potentially available for rotation cropping. The inclusion of the 20 per cent of hilly and miscellaneous lands now cleared and suggested for permanent pastures raises the total area feasible for agriculture to about 81 per cent. The remaining 19 per cent, or approximately 81,300 acres, of hilly and mis-

cellaneous lands now in woodland is not recommended for clearing. Considering the costs of clearing, fertilization, and in places drainage, this woodland area would be marginal in its best alternative use as permanent pasture or hay land. Its best use is as a source of fuel wood for flue-curing tobacco, especially if all other woodlands were cleared as suggested in Table 1. Many other forest products are also potentially available under good forest management as well as accessory uses for homesites, recreation, wildlife, and watershed purposes.

For purposes of estimating suitable uses, rotation, lime, and fertilizer

TABLE 1. GENERALIZED LAND CLASSES AND PRESENT AND PROPOSED LAND USES, MECKLENBURG COUNTY, VA.

Generalized Land Class	Predominant Slopes	Soil Mapping Units	Area		Approximate Present Land Use				Proposed Land Use		
					Cropland, Idle, Pasture, and/or Brush		Woodland		Rotation Crops Hay and/or Pasture	Woodland	Permanent Pasture
	%	Number	Acres	%	%	Acres	%	Acres	%	%	%
Undulating	2–6	32	183,924	43.4	60	110,354	40	73,570	100	0	0
Rolling	6–12	28	121,192	28.5	40	48,477	60	72,715	100	0	0
Nearly level	0–2	5	18,886	4.3	60	11,332	40	7,554	100	0	0
Subtotals		65	324,002	76.2		170,163		153,839			
Hilly and Misc.[1]	12–20	16	101,598	23.8	20	20,320	80	81,278	0	80	20
Grand Totals		81	425,600	100.0		190,483		235,117			

[1] Chiefly poorly drained alluvial soils, very difficult to drain artificially.

needs, the recommendations in the soil survey report were generalized. Based on past-cropping practices, a generalized row crop—small grain—one or two year hay and/or pasture rotation is best adapted and provides the most flexibility for alternative agricultural opportunities for most of the county. Corn is the principle row crop at present, and cotton is an important but minor alternative. Wheat, oats, and barley are the principal small grains. Mixed alfalfa or red clover and grasses make the best hay, and orchard grass–ladino clover is one of the best pasture alternatives. Under the common or average practices of soil management, the row crop receives 200 to 250 pounds of fertilizer per acre, the small grain 100 pounds or less, and the hay or pasture crop little or no fertilizer and little or no lime. Under good management, the row crop receives 500 to 800 pounds per acre, the small grains 400 to 600 pounds, and the hay or pasture crop 200 to 500 pounds of mixed fertilizer and about one ton of lime per rotation. Still higher rates of fertilization are possible at higher levels of soil management with corresponding increases in output.[10] In order to correct the prevailing low levels of fertility and strong acidity,

[10] For more specific recommendations as to rates and analyses see Fertilizer Recommendations for Virginia, Bulletin 183, Virginia Agricultural Extension Service, Blacksburg, July 10, 1950.

the estimates in Table 2 are based on the application of 800 pounds of mixed fertilizer and 2 tons of lime. Such initial applications should satisfy the fertilizer requirement for the first row crop and the lime requirement for the first rotation.

Although minor from the standpoint of acreage, tobacco is the most important crop in the county from the standpoint of gross value. It is

TABLE 2. LAND IMPROVEMENT ESTIMATES, MECKLENBURG COUNTY, VIRGINIA

Generalized Land Class	Lime		Fertilizer		Water-Control Practices	Clearing	Grand Totals
	Tons[a]	Cost[b]	Tons[c]	Cost[d]	Cost[e]	Cost[f]	Cost
Rotation Crop, Hay and/or Pasture Land							
Undulating	190,708	$1,334,956	45,642	$2,053,890	$ 662,124	—	$4,050,970
Rolling	96,954	678,678	19,391	872,595	290,862	—	1,842,135
Nearly level	22,664	158,648	4,533	203,985	—	—	362,633
Subtotals	310,326	$2,172,282	69,566	$3,130,470	$ 952,986	—	$6,255,738
Clearing Woodland for Rotation Crops, Hay and/or Pasture							
Undulating	147,140	$1,029,980	29,428	$1,324,260	$ 441,420	$7,357,000	$10,152,660
Rolling	145,430	1,018,010	29,086	1,308,870	436,290	7,271,500	10,034,670
Nearly level	15,108	105,756	3,022	135,990	—	755,400	997,146
Subtotals	307,678	$2,153,746	61,536	$2,769,120	$ 877,710	$15,383,900	$21,184,476
Permanent Pasture							
Hilly and Misc.	40,640	$ 284,480	6,096	$ 170,688	—	—	$ 455,168
Subtotals	40,640	$ 284,480	6,096	$ 170,688	—	—	$ 455,168
Summary of all Land Improvements							
Undulating	337,848	$2,364,936	75,070	$3,378,150	$1,103,544	$ 7,357,000	$14,203,630
Rolling	242,384	1,696,688	48,477	2,181,465	727,152	7,271,500	11,876,805
Nearly level	37,772	264,404	7,555	339,975	—	755,000	1,359,779
Hilly and Misc.	40,640	284,480	6,096	170,688	—	—	455,168
Grand Totals	658,644	$4,610,508	137,198	$6,070,278	$1,830,696	$15,383,900	$27,895,382

[a] At the rate of 2 tons per acre, minus the non-treatment of approximately 15,000 acres of tobacco land.
[b] Estimated cost at $7 per ton.
[c] At the rate of 800 pounds per acre on rotation cropland, 1,000 pounds per acre on approximately 15,000 acre of tobacco land, and 600 pounds superphosphate per acre on permanent pasture.
[d] Estimated cost at $45 per ton for mixed fertilizer; $28 per ton for superphosphate.
[e] Estimated cost at $6.00 per acre principally for contour stripping.
[f] At an estimated cost of $100 per acre.

grown in short specialized rotations, however, and only on certain soils because of their influence on the quality as well as the quantity of the crop. High levels of fertilization and management are required, and usually only a few acres per farm are grown because of the high labor input. For these reasons as well as the strict production controls in effect, tobacco-growing is a highly specialized and intensive enterprise, and its expansion is highly improbable. In Table 2, the specialized requirements of the approximately 15,000 acres in tobacco were lumped together and included in the undulating land class which contains most of the best soils for tobacco. Ordinarily, the best possible practices known are employed in

tobacco culture. Because of the danger of black root rot, no lime is recommended, but an average of about 1,000 pounds per acre of mixed fertilizer is used.

Good management of the hilly and miscellaneous land recommended for permanent pasture should include an initial application of about 600 pounds per acre of 20 per cent superphosphate or a fertilizer such as 0-14-7 or 0-14-14 and about 2 tons of lime. Subsequent annual applications should consist of 200 to 500 pounds per acre of 20 per cent superphosphate or a mixed fertilizer such as 2-12-12. About one ton of lime every 4 years should be adequate. Under average or common practices, little or no mixed fertilizers, superphosphate, or lime are applied to permanent pastures.

According to the Soil Conservation Service, contour strip cropping is the most widespread and recommended water-control practice in the Virginia Piedmont. Some terracing is recommended for land devoted almost exclusively to tobacco production. Because of the limited amount as well as the selection of the most favorable soils and the slopes for tobacco culture, terracing is of negligible importance. At the present time, the Production and Marketing Administration is allowing $4.00 per acre for contour stripping. This figure is reported to be 75 per cent of the actual cost including some land conditioning such as the removal of an occasional fence or other obstruction. On a proportionate basis, $6.00 per acre probably represents a conservative estimate of the total costs to effect adequate water-control practices.

According to information obtained from the Division of Soil Management and Irrigation, Bureau of Plant Industry, Soils, and Agricultural Engineering, and the Division of Research, Soil Conservation Service, the cost of clearing woodland should be about $100 per acre under present conditions in this area. Such clearing operations include the use of power-driven felling and bucking equipment and bull-dozers for removing stumps. No deductions from the cost of clearing estimates were made for the value of the forest products removed. Information from the Section of Forest Economics of the Forest Service indicates that the value of the timber products in some areas might more than pay for the cost of clearing. Under good forest management, stands may run up to 25,000 bd. ft. per acre. Due to repeated cutting of the better species, however, the average timber stand is typically much closer to 2,000 bd. ft. of merchantable material per acre. Pine pulpwood is another important use of material too small for timber purposes, and hardwood fuel wood for flue-curing tobacco is a very important product. Based on the average estimate of 2,000 bd. ft. of timber at $10 per thousand or 10 cords at $1.50 for pulp or fuel wood, indications are that the average acre of woodland might yield about $20 in forest products on the stump.

Application of the foregoing generalized recommendations to the land conditions in Mecklenburg County resulted in the estimates presented in Table 2. Allowing for the approximately 81,300 acres of woodland not recommended for agricultural development, the remaining 344,300 acres could be improved at an estimated cost of about $28 million. Three such counties in the Cecil-Appling Soil Association area would constitute about 1,032,900 acres of land available for improvement as contrasted with the 1,029,500 acres estimated as irrigable by the Bureau of Reclamation in the Columbia Basin Project. Land improvements in three counties such as Mecklenburg would thus cost about $84 million. Allowing an additional $2,500 per farm for the approximately 12,000 farms in such a tri-county area, this figure may be increased by $30 million to $114 million to provide for additional farm facilities to efficiently handle the increased agricultural production obtainable.

Whereas approximately the same total acreage could thus be developed for agricultural production in either area, indications are that the costs of improvement will be about 7.5 times as great, $860 million in contrast to $114 million, for the Columbia Basin Project as for an area equivalent to three counties similar to Mecklenburg, Virginia. Stated in another way, 7.5 acres of land could be developed in areas similar to Mecklenburg County for every acre developed in areas similar to the Columbia Basin.

Still another way of presenting the alternatives involved in this analysis is in bushels of corn obtainable from the investment of $860 million in the alternative areas. For such purposes, a generalized yield estimate of 75 bushels of corn per acre under good management practices in either area seems reasonable. Because 7.5 acres of land could be developed in areas similar to Mecklenburg County for every acre in the areas similar to the Columbia Basin, 7.5 million acres $\times$ 75 bushels per acre = 563 million bushels of corn would be obtainable in the former area to 1 million acres $\times$ 75 bushels per acre = 75 million bushels in the latter area. Individuals and society would thus have an additional 488 million bushels of corn, or the approximate equivalent in other agricultural products, for the same investment of $860,000,000.[11]

In addition to the essentially complete land improvements discussed above, estimates of other alternatives of a more limited or partial nature can be derived from Tables 1 and 2. Perhaps the most important is the

[11] On the basis that the water supply would be more certain or that row crops might be grown more often, some reviewers of this paper are of the opinion that the Columbia Basin Area would yield about 20% more than the Piedmont. On such a basis, these figures would become 7.5 million acres $\times$ 75 bushels per acre = 563 million bushels of corn from the Piedmont area vs. 1 million acres $\times$ 90 bushels per acre = 90 million bushels from the Columbia Basin, or a difference of 473 million bushels from the same investment of $860 million. Similar land quality considerations would change the relative acreage ratio from 7.5:1 to 6.25:1.

improvement of the areas now essentially clear and available for rotation crops, hay and/or pasture. There is about 170,200 acres of such cleared land in Mecklenburg County which could be improved at an estimated cost of about $6,255,000. Six times such an area in the Piedmont would aggregate about 1,021,000 improvable acres at a cost of about $37,500,000. Allowing an additional $1,000 per farm to handle the increased output for the approximately 24,000 farms which could be involved in such a 6-county area in the Piedmont, this estimate could be increased by $24 million to $61.5 million in contrast to $860 million for the Columbia Basin. This is equivalent to improving about 14 cleared acres in the Piedmont for every acre in the Columbia Basin. The inclusion of the cleared areas of hilly and miscellaneous lands in Piedmont for use as permanent pasture would have little effect on the foregoing figures.

At the other extreme, the clearing and improvement of woodland for rotation crops, hay and/or pasture in the Piedmont can also be compared with Columbia Basin. There are about 154,000 acres of woodland in Mecklenburg County improvable at an estimated cost of about $21,200,000. Some 6.7 times such an area in the Piedmont would aggregate about 1,031,800 improvable acres at a cost of about $132,040,000. Allowing an additional $1,000 per farm to handle the increased output for the approximately 27,000 farms which could be involved in such a 6.7-county area in the Piedmont, this estimate could be increased by $27,000,000 to $159,040,000 in contrast to $860,000,000 for the Columbia Basin. This is equivalent to clearing and improving about 5 acres now in woodland in the Piedmont for every acre in the Columbia Basin.

With such alternatives as presented by this analysis clearly possible,[12] the future investment of both private and public funds to increase agricultural production should be closely examined to make certain they are the most efficient alternatives possible. This paper has attempted to analyze the capital costs of getting land into agricultural production in the semi-arid West and humid Southeast by spelling out reasonable alternatives for such investment in the two different settings. The proposed approach is suggested as a promising means of establishing guides to future investment for increasing agricultural production in the nation as a whole. The soundest possible investment will become increasingly important to the welfare of the country as our population and living standards increase.

[12] See in particular B. A. Krantz, *Fertilize Corn for Higher Yields*, Bulletin 366, N. C. Agri. Exp. Station 1949, for detailed experimental results and instructions for increasing corn yields. See also "Virginia Bests North Carolina in Corn War Again, Leads Nation in Rate of Yield Increases," *What's New in Crops and Soils*, V. 3: 41 pp., 1951, which reports the statewide yield of corn in Virginia was 49 bushels in 1950. This is a gain of 49.4 per cent over the 1940-49 average for Virginia. North Carolina with an average yield of 37 bushels, an increase of 44.4 per cent over the 1940-49 average, was second in the nation.

ECONOMIC NATURE OF THE COOPERATIVE ASSOCIATION

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THE cooperative association is an association of firms or households for business purposes—an economic institution through which economic activity is conducted in the pursuit of economic objectives. An understanding of economic concepts is basic to the sound organization and operation of cooperatives, and to public policies toward cooperative activity which are consistent with society's objectives. Much has been written about cooperative activity, but the literature is dominated by socio-reformistic, historical, and descriptive interpretations. The so-called basic "principles of cooperation" are referred to frequently and with considerable ardor. Seldom is their significance seriously questioned. Economic theorists have seldom addressed themselves specifically to the cooperative association. Where cooperative activity has been mentioned at all, the cooperative has been treated as a special kind of corporation, covered quite adequately by the general theory of the firm. As Aizsilnieks has suggested,[1] such a treatment led Clark[2] to generalizations regarding the effect of cooperatives on general welfare which are difficult to justify, at least until further analysis has been made.

This article attempts to develop, on the basis of the contemporary economic theory of the firm—but with adaptation to the cooperative structure—a realistic, workable, and reasonably complete theory of the economic nature of the cooperative association. This theoretical framework involves: (1) the economic structure of the cooperative association; (2) the economic relationships among the participating units; and (3) the conditions necessary for profit maximization in the cooperating firms.

A. *The Jointly Operated Plant*

When a group of individual firms form a cooperative association, they agree mutually to set up a plant and operate it jointly as an integral part of each of their individual firms (or households in the case of a consumer cooperative).[3] The cooperative has no more economic life or purpose apart

[1] Arnolds P. Aizsilnieks. Farmer Cooperatives and Economic Welfare—A Reply. *This Journal.* Vol. 34, August 1952. p. 400-403.

[2] Eugene Clark. Farmer Cooperatives and Economic Welfare. *This Journal.* Vol. 34. February 1952. p. 35-51.

[3] Cf. Edwin G. Nourse, *The Legal Status of Agricultural Cooperation.* The Macmillan Co. New York. 1927. p. 171, and Frank Robotka. Lego-Economic Implications of Cooperation. *In American Cooperation; 1946.* p. 522-533. American Institute of Cooperation. Washington, D.C. 1946.

from that of the participating economic units than one of the individual plants of a large multi-plant firm. Instead the participating firms agree to function *coordinately* with respect to their joint activity. This agreement runs multi-laterally among the participating firms, rather than between each of them and the joint activity as such. These participating firms must function as an economic team in relation to their coordinated activity. They must forgo some of their individual sovereignty in favor of themselves as a team. It is technically correct to speak of the cooperative plant and of cooperating firms, but not of the cooperative firm.

As an economic institution, the cooperative association is not an organization of persons, either as laborers, as capital contributors, or as patrons, for that matter. It is an organization, as Emelianoff and Robotka both point out, of sovereign economic units—firms or households.[4] Although it is descriptively correct to say that a cooperative association is a business organization owned and controlled by its patrons and operated for their benefit as patrons, such a statement contributes nothing to the understanding of the economic structure of the cooperative. Capital, and even labor, may be involved in patronage; but patronage, per se, is not a productive resource capable of earning an economic return in the production of goods and services. Rather, the value of patronage to a given firm is reflected in the nature of the demand and supply functions faced by that firm. It is not possible "to organize an economic system from the standpoint and for the benefit of the . . . patron,"[5] as the controller of a given factor of production. It is possible for firms jointly to organize and operate a common plant with the idea of maximizing the economic returns to each of the individual associated firms.

The entrepreneurs of the associated firms each must allocate productive resources to their common plant, the same as a multi-plant firm must allocate resources to each of its plants. The associated firms in a cooperative cannot be in static partial equilibrium (under the profit maximization assumption) unless the marginal conditions for optimum resource allocation in each firm are met. This means that for each participating firm the marginal productivity of each resource allocated to the cooperative plant must be equal to the marginal productivity of that resource in the individual plants of that member firm. In addition, the marginal productivity of the last dollar must be equal in every use within each firm.[6]

In short, when two or more economic units cooperate with respect to some function or activity that is integrally related to their individual economic operations, the result is not a new firm; instead it is a common

[4] Ivan V. Emelianoff. *Economic Theory of Cooperation.* Ivan V. Emelianoff. Washington, D.C. 1942. p. 249, and Robotka. *op. cit.* p. 526.

[5] Nourse. *Op. cit.* p. 21.

[6] Cf. Richard Phillips. Economic Nature of the Cooperative Association. Unpublished Ph.D. Thesis. Iowa State College Library. Ames. 1952. p. 149-246.

economic plant. The cooperative *association* consists of the sum of the multi-lateral agreements among the firms participating in the joint activity, in order that these firms may function coordinately through their common plant. The cooperative *activity* is an economic plant operated jointly as a part of these several firms. The cooperative, as such, has no entrepreneurial unit; its member units each have their entrepreneur. Except for the coordination necessary to enable a group of economic units to operate a common plant jointly, the member units function independently of one another in the pursuit of their individual economic careers. Each participating firm arrives at production equilibrium considering its separate

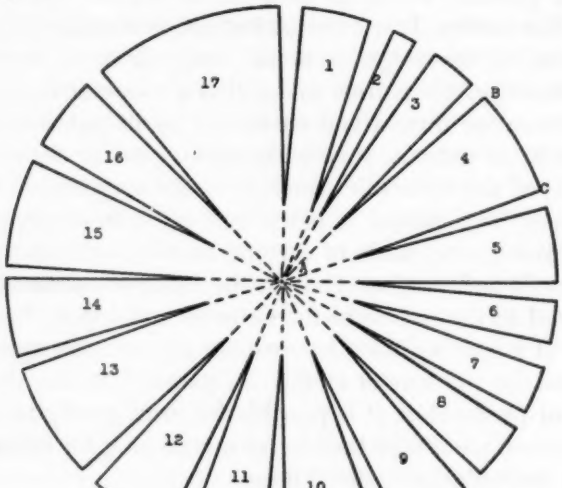

FIGURE 1. THE COOPERATIVE STRUCTURE

activities *plus* its proportionate share of the joint activity as an integrated production unit.

This structure in the cooperative association is visualized in Figure 1. The triangular numbered sections represent the member firms. The small uninscribed circle at A denotes their joint plant. Notice that the complete firm in each case includes a part of the joint plant at the center (*i.e.*, BAC for firm 4). Observe that there is no connection between the firms except where they come together in the joint plant. Note also that the joint plant is indistinct except as a part of each of the member firms. If all firms were to withdraw (move outward from the center) there would be no cooperative plant left. If one firm were to withdraw (number 3 for example) a section of the plant would be removed, and its size correspondingly reduced.

B. *Relationships Among Participating Firms*

The participating firms usually do not share their joint plant equally. The proportion of the total joint plant included as a part of each of the participating firms is defined by the relative size of the production activities in the individual plant (or plants) of each firm with which the activities conducted through the joint plant are integrated (see Figure 1). This *proportionality* determines the manner in which the participating firms will share all inputs, including entrepreneurial inputs, and all outputs—all costs and benefits—of the joint plant. In order to achieve a static optimum allocation of resources *among* the participating firms, the entrepreneurial decisions, the bearing of uncertainties, the financial responsibility, the economic use, the costs, and the economic benefits in connection with the joint activity must be shared by the firms on the basis of this proportionality. Of course, only the participating firms will share in these economic functions which arise in their joint activity.

In other words, the firms which participate in a single department joint plant in each operating period will share all economic functions in connection with the joint plant on a proportional basis. From the standpoint of economic structure, voting in the cooperative association will not be shared on a per firm (one-firm one-vote) basis, but on a proportional basis. The economic use of the joint plant will be shared on a proportional basis. All costs, including costs of risks, will be shared on a proportional basis. Uncertainty bearing will not be shared on a per firm basis, but on a proportional basis. The financial responsibility (*i.e.*, either providing the actual capital, or paying the interest and providing the security required to obtain it) will be shared on a proportional basis. And the economic benefits, if any, of the joint activity will be shared by the participating firms on a proportional basis.

Given perfect knowledge and certainty, proportionality also applies over time and between departments. Under these assumptions, the firms jointly operating each department in the joint plant will participate in all of these economic functions proportionately as they share that department. Furthermore, all functions arising from the operation of the joint plant that are common to several departments will be shared by the groups of firms participating in each of the departments concerned. Such interdepartmental functions will be shared on a basis proportional to the fraction of the total operation of the joint plant represented by each department. Functions specific to a given department will be of concern only to the firms jointly operating that department.

What about the interfirm relationships extending over time which arise from participation in the joint activity? A given proportional sharing of the joint plant (such as that shown in Figure 1) for one operating period will not necessarily hold for other time periods. Proportionality must

therefore be maintained between the groups of participating firms in each operating period as well as within each such group. This means that all functions which extend over time will be shared by the groups of firms operating the joint plant in each period on a basis proportional to the relative size of the plant in each period.[7] Functions which are specific to a given operating period will be participated in only by the group of firms sharing in the joint activity in this period.

Even when the assumptons of perfect knowledge and certainty are dropped, proportionality determines the manner in which the firms participating in a joint plant share the economic functions in the joint activity —including those which are interdepartmental and intertemporal. However, in this case planned proportionality—rather than actual realized proportionality—is the guide. Also, under these conditions, it may be economic to share functions which are specific to a given department or time period interdepartmentally and intertemporally in order to reduce the expected dispersion around the the most probable anticipated values of relevant variables facing each participating entrepreneur. How far the firms participating in the joint plant will go in this direction depends upon: (1) the anticipated uncertainties; (2) the expected reduction in this dispersion by interdepartmental and intertemporal pooling; (3) the percentage of owned equity in the participating firms; and (4) the indifference toward relative certainty and relative efficiency of the majority of the participating entrepreneurs. To the extent that specific functions are pooled, they also will be shared among the groups of participating firms involved on the basis of anticipated proportionality.

C. *Profit Maximization in Participating Firms*

Following the orthodox static assumptions, the cooperating firms individually seek to maximize their profits—considering that part of their operations in the jointly operated plant as well as their individual operations outside of it. Two conditions are necessary if this objective is to be accomplished. First, each participating firm must be in production equilibrium. Second, the joint plant must be of optimum size. Although these two criteria are related, it is possible to satisfy either without satisfying the other. The profits of the participating firms are not at their absolute maximum unless both are met.

The necessary production equilibrium conditions are the same as those for any firm. The participating firms must (1) achieve the best production combination, and (2) be of optimum size. The best combination of outputs will be produced at the least cost combination when the ratio of the

[7] Provided the relationships affect each operating period on a basis proportional to the size of the plant operation in each period.

marginal expenditure for the input[8] to the product of the *marginal physical productivity of the input*[9] times the *marginal return for the output produced*[10] is equal between all inputs in the production of all outputs within the firm. The optimum firm size will be defined at the output which equates the marginal revenue with the marginal cost of each product duced and for all products taken together. These conditions together mean that the marginal revenue productivity[11] must be equal to the marginal expenditure for each input in all alternative uses within the firm.

The participating firms are ordinarily vertically integrated in the sense that the output of the joint plant is the raw product input of the individual plants of the participating firms—or alternatively, the output of the individual plants of the participating firms is the raw product input of the joint plant.[12] As products move from one plant to another in a vertically integrated firm, no transfer of title takes place and no price is established for them. Such a firm is not interested in the profitability of any one of its plants considered alone. Rather it is interested in the profitability of the complete chain of integrated plants operating as a unit. The optimum output is determined on the basis of the complete operation. If measured in comparable units, the equilibrium output will be the same for each of its plants. The vertically integrated firm determines this optimum output by equating the sum of the marginal cost functions in all plants with the marginal revenue in the final plant from which the product is marketed.[13] The cooperating firm equates the sum of the marginal cost in its individual plant or plants and the marginal cost in the joint plant

[8] Defined as the increment of the firm's total cost for inputs resulting from an additional unit of this input.

[9] Defined as the net addition to the physical outputs of the firm resulting from the use of an additional unit of this input.

[10] Defined as the increment of the firm's total revenue for output resulting from the sale of the added amount of this output plus the sale of the net change in amount of other outputs.

[11] Defined as the product of marginal physical productivity and marginal return.

[12] The exception is the plant operated jointly by two or more firms to procure specific capital resources, such as farm machinery for agricultural firms. In this case each participating entrepreneur will equate the marginal cost in the joint plant with the marginal revenue productivity of the resource in his individual plant. Such participating firms are integrated in the sense that several stages in the production process are brought under one entrepreneurial control. The more narrow definition of vertical integration used in the text is necessary, however, for analytical purposes.

[13] Cf. Werner Zvi Hirsch. The Economics of Integration in Agricultural Marketing. Unpublished Ph.D. Thesis. Univ. of California Library, Berkeley. 1950. p. 97-144. Hirsch did not deal with this general case, although it follows logically from his analysis. He dealt instead with the following conditions respectively: (1) no charges (costs) in any plant except that farthest from the consumer, (2) only fixed charges (costs) in all plants except that farthest from the consumer, (3) per unit charges (costs) at a constant rate in all plants except that farthest from the consumer, (4) where fixed payments are made outside the firm for services, and (5) where a fixed per unit payment is made outside the integrated firm for services.

with the marginal revenue facing the firm in the market where the product is sold. This criteria applies both to short run and to long run analyses.

The relevant segment of the marginal cost function in the joint plant to each participating entrepreneur is that beginning with the sum of the equilibrium outputs of all other participating entrepreneurs, rather than at zero output. Each entrepreneur must consider the additional costs in the joint plant resulting from his volume of output. The precise equilibrium output for any one participating firm cannot be determined unless

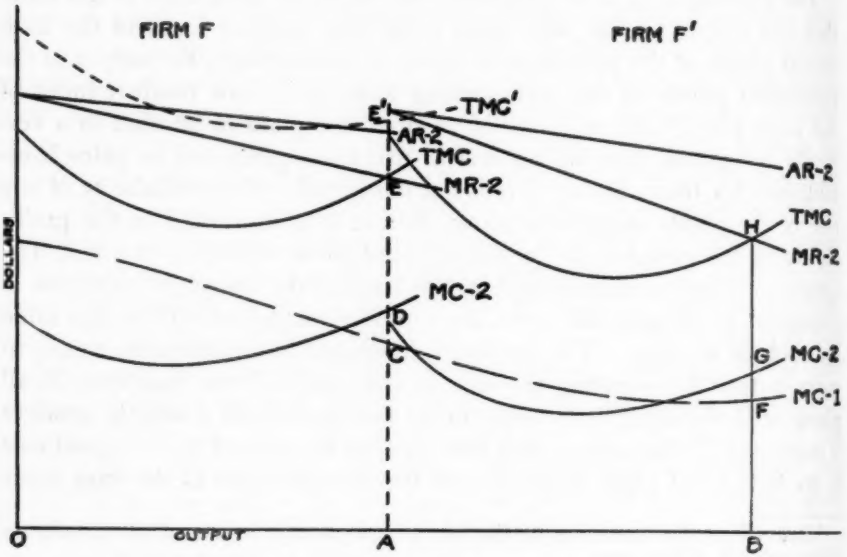

FIGURE 2. PARTICIPATING FIRM EQUILIBRIUM. TWO FIRM PLANT

the equilibrium output for all others is given; without this information the exact segment of the marginal cost function which is relevant cannot be determined.[14] Formal solution of the optimum output for each participating firm and in the joint plant, given the number of participating firms, is possible by simultaneous equations only. If the output product of the participating firms is marketed from their joint plant, everything which has been said about the relevant range of the joint plant marginal cost curve to each firm is true also of the relevant range of the marginal revenue curve.

The equilibrium position for two cooperating firms is illustrated in Figure 2. The two firms, F and F', operate plant 1 jointly. They each operate a second plant entirely independently of the other. The output of the joint plant is used entirely as an input for the two independent plants.

[14] Of course it is not necessary to make this determination if the marginal cost function is horizontal over the relevant range.

MC-1 is the marginal cost function in the joint plant. MC-2 for firm F is the marginal cost in the second plant operated by this firm and MC-2 for firm F′ is the marginal cost in its second plant. The output for the joint plant and the second plant of each firm is assumed to be in comparable units and measured on the same scale. Firm F′ produces at the output AB where the sum of the marginal cost in the joint plant and the marginal cost in its second plant equals the marginal revenue in the second plant. The relevant segment of the MC-1 curve to firm F′ is CF. The TMC curve is the sum of MC-2 for firm F′ and the segment of the MC-1 curve to the right of C. The sum of BF and BG is equal to BH. The equilibrium output for firm F′ assuming the best production combination, is AB, as defined by the intersection of TMC and MR-2, at H.

Firm F produces at the output OA where the sum of the marginal cost in its second plant and the marginal cost in the joint plant equals the marginal revenue in the second plant. The revelant segment of the MC-1 curve is that starting at the equilibrium of firm F′. In this diagram AB is equal to OA, so that the relevant segment of this curve to firm F is also CF. The TMC curve for firm F is the sum of its MC-2 curve and the MC-1 curve to the right of C. The sum of AD and BF is AE. The equilibrium output for firm F is defined by the intersection of TMC with MR-2 at E as OA units. If firm F operated plant 1 alone the total marginal cost to the firm would be TMC′ rather than TMC, since the relevant segment of MC-1 would be that starting from zero, and AC plus AD is equal to AE′. In such case the firm would not be able to cover costs, as contrasted to the positive profit margin when plant 1 is operated jointly with another firm.

Aside from variations due to the adjustment to optimum output in each firm, the size of the joint plant is determined by the number and size of the participating firms. One reason firms find it economic to operate a plant jointly, rather than carry out the same production processes individually, is a decreasing long run average cost curve over a considerable range for a part of the total economic function, or contemplated function, of the several firms. By pooling this part of their activities and functioning coordinately through a common plant, they are able, under these conditions, to increase their economic efficiency by approaching more nearly optimum size for this operation. Firms which jointly operate a common plant, once they have achieved the best production combination in their joint plant, are interested in the plant size which will maximize plant efficiency and make the greatest possible contribution to the profits of each participating firm. When the optimum size for the joint plant has been determined, this optimum is maintained over the long run by varying the number of participating firms. Plant size is reduced by failure to replace firms that retire from participation; it is expanded by encouraging new firms to participate.

How is the optimum size for the joint plant determined? The joint plant will be of optimum size when the long run average net return from the plant is at a maximum. This is true because the greatest contribution of the plant to the profit of each participating firm, regardless of the size of the firm, will be at that point.[15] Where the output of the joint plant is raw product or specific resource input for the individual plants of the participating firms, optimum size in the joint plant is defined by the minimum point in the long run average cost function in the joint plant. In this case, since they operate the joint plant to supply their individual plants, the participating firms face no revenue function from their joint plant.

Next, consider the case where the output of the individual plants of the participating firms is the raw product input of the joint plant. Here the optimum size for the joint plant is defined at the output which maximizes the vertical distance between the long run average revenue curve and the long run average cost curve in the joint plant. The joint plant long run average cost function in this case is net of the cost of raw product inputs supplied from the individual plants of the participating firms.

Typically, the cooperative activity consists of more than one department. Such a practice is economic when the production carried on by the participating firms makes it desirable and the long run per unit joint cost in the common plant decreases with volume. In such case, the participating firms will all maximize their profits by adding departments in the joint plant, each of optimum size, until a size is reached which minimizes the long run per unit joint cost.

The determination of the long run optimum size in the joint plant is distinct from the determination of the long or short run optimum size for each participating firm. Optimum long run joint plant size is achieved by varying the number of participating firms, each of long run optimum size. Both optimums must be reached if the profits of each participating firm are to be an absolute maximum.

D. *Dynamic Consideration*

Under dynamic conditions, the participating firm is interested in the maximum expected discounted value of the profit stream. But such a firm also is interested in the minimum expected variation in this stream over time. Each entrepreneur, in any given planning period, conceivably must achieve some optimum balance between these two objectives.

The necessary conditions for the maximum discounted expected profit stream for the firm in any period are similar to those under static conditions. The firm will produce the best combination of outputs at the least

[15] Cf. Richard Phillips. Sharing Risks and Uncertainties in Farmer Cooperatives. Unpublished M. S. Thesis. Iowa State College Library. Ames. 1949. p. 72-84.

cost combination when the ratio of the discounted expected marginal expenditure to the discounted expected marginal revenue productivity is equal for all inputs in all alternative uses within the firm.[16] The optimum planned output in each period is determined by equating the expected discounted marginal cost function and the expected discounted marginal revenue function. The sufficient conditions must provide that any time the firm is thrown out of equilibrium, adjustments to meet again the necessary conditions will cause conversion to the efficiency equilibrium.[17]

In order to be in equilibrium under the objective of maximum stability of the profit stream over time, the participating firm must allocate resources and plan production so that the expected marginal gain in stability over time is equal to the expected marginal cost of the organization for stability. The ratio of the expected marginal gain in stability to the expected marginal expenditure of organizing for stability must be equal for all methods used by the firm to achieve profit stability over time. This equilibrium must also be stable in the sense that if the firm is thrown out of equilibrium, adjustments to meet again the necessary conditions will cause conversion to the stability equilibrium.

Given: (1) the production plan which maximizes the discounted value of the expected stream of profits, and (2) the production plan which minimizes the expected dispersion around the most probable profits over time for a participating firm, the task is resolved into the selection of the best compromise position between the two. The location of this compromise position for a given firm will depend upon: (1) the "technical" relationship between these two objectives; and (2) the indifference map of the entrepreneur defining the relative importance of the two objectives to him. If both the technical relationship and the indifference map are assumed to be definite and clearly defined and without discontinuities, then a unique optimum position will be described by the point of tangency of the technical relationship function and an indifference curve between these two objectives. The only rational segment of the technical

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[16] Provided the ME and MRP functions are so defined as to include intertemporal relationships. The same input or output in different time periods is considered as separate inputs and outputs. The anticipations are adjusted for uncertainty premiums and discounts. A constant discount rate is assumed in each planning period. Cf. the following:

J. R. Hicks. *Value and Capital.* 2nd. ed. The Clarendon Press. Oxford. 1946. p. 192-226.

Sune Carlson. *A Study on the Pure Theory of Production.* Stockholm Economic Studies. No. 9. P. S. King and Son, Ltd. London. 1939. p. 103-126.

Oscar Lange. *Price Flexibility and Employment.* Cowles Commission for Research in Economics. Monograph No. 8. The Principia Press, Inc. 1944. p. 20-44.

Albert Gaylord Hart. *Anticipations, Uncertainty and Dynamic Planning,* Univ. of Chicago Press. Chicago. 1940.

[17] Cf. Paul Anthony Samuelson. *Foundations of Economic Analysis.* Harvard University Press. Cambridge. 1948. p. 257-349.

relationship function is that part where the two objectives are competitive; the entrepreneur can improve his position by moving into this range regardless of the slope and shape of his indifference curves toward the two.

Such an optimum position is illustrated in Figure 3. In the diagram, efficiency is measured on the X axis, increasing to the right, and stability is measured on the Y axis, increasing upward. The distance OK repre-

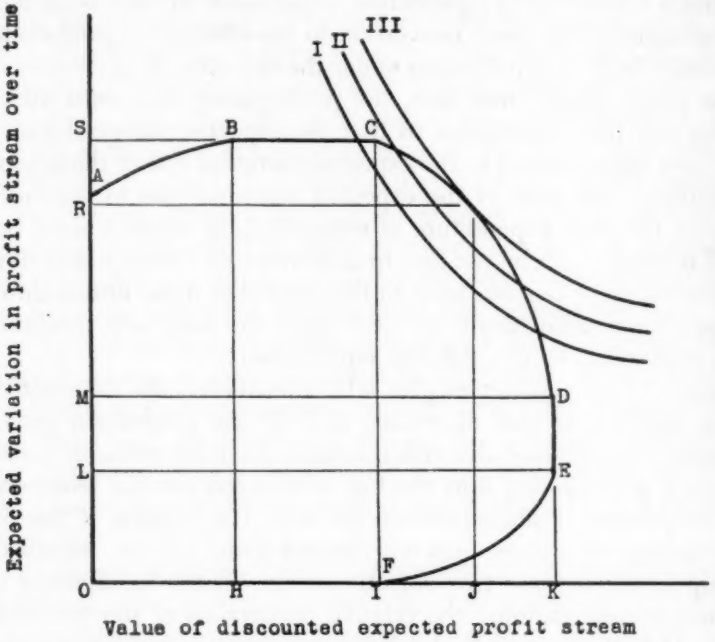

FIGURE 3. RELATIONSHIP BETWEEN EFFICIENCY AND STABILITY OBJECTIVES

sents optimum dynamic efficiency and OS represents optimum stability of profits over time. The technical relationship between efficiency and stability is represented by the curve ABCDEF. It illustrates the probable ranges of: (1) complementarity at very low efficiency, and at very unstable organization; and (2) independence (BC and ED) at moderate efficiency and stability. The only segment representing rational combinations of anticipated efficiency and stability is CD, where the two objectives are competitive. The best position is defined by the point of tangency of the ABCDEF curve and indifference curve III at OJ efficiency and OR stability over time.

The conditions for optimum efficiency in the firm participating in a joint plant pointed out in the previous section are applicable under dynamic conditions if discounted anticipated variables, including allowances for uncertainties, are substituted for given ones and intertemporal relationships between variables are provided for.

What about the conditions for optimum stability in the participating firm? *First,* as long as it is economic, the anticipated conflict of interest among participating entrepreneurs must be minimized. This means an association of reasonably homogeneous, rather than heterogeneous, participating firms. Specification of the conditions of participation in the articles and bylaws of the association will also help to minimize this anticipated conflict of interest. It will also cause each entrepreneur to face less uncertainty as to the continued participation of the other firms.

Second, aside from this uncertainty as to the attitudes and actions of the other entrepreneurs, participation in the joint activity in itself tends to reduce the anticipated variability of the profits of each firm over time. Vertical integration, by reducing the number of markets of concern to the participating entrepreneur, makes the profits of his firm more stable under temporary fluctuations in market conditions. Also, because of the higher degree of coordination of the various processes, the vertically integrated operation will ordinarily be more adaptable to changing technical and economic conditions facing the firm.

The participating firms may gain further stability by diversifying horizontally and laterally, both in the joint plant and in their individual plants. Where there are several departments in the joint plant—all of which are integrated with the individual activities of the participating firms—anticipated stability is usually greater than would otherwise be the case. This is particularly true where counter-cyclic fluctuations are expected among the activities and outputs of the partcipating firms.

The opportunity to pool uncertainties within the group of participating entrepreneurs is another source of increased anticipated stability of profits over time to each firm. It often will be economic, because of the gain in anticipated stability, to pool uncertainties of the joint plant operation which are specific to a given department or time period between departments and over time. All such increases in the anticipated stability of profits to the participating firms over time result directly from the fact that they have carried out "concerted integration."[18]

Participation in the joint plant often reduces capital-rationing and other market imperfections facing the firm. Consider capital-rationing as an example. Participating firms usually are able to obtain credit as a group for the joint activity as such—even though some of them individually are unwilling or unable to obtain the use of any more capital. The structure provides machinery whereby participating firms with a high marginal productivity for capital may borrow from those with a low marginal productivity for capital. Firms are willing to borrow more capital because they jointly assume the anticipated new uncertainties arising from the addi-

[18] *See* D. H. Robertson. *The Control of Industry.* Harcourt, Brace, and Co. New York. 1923. p. 49.

tional borrowed capital and expanded production activities. The chief result of the reductions in capital-rationing and other market imperfections is that they provide for an increase in expected economic efficiency for each participating firm without a corresponding decrease in the expected profit variability over time, and vice versa.

E. *Practical Considerations*

The concept of the basic economic structure of the cooperative association, and the interfirm relationships resulting from the joint ownership and operation of a common plant, should provide an important working tool. The applied economist, the cooperative attorney, the cooperative accountant, the practical cooperative leader, and the legislator alike should find it useful. It should avoid the insurmountable difficulties and inconsistencies which arise when the cooperative is looked upon as a firm and its operations studied apart from the individual operations of the participating firms. The concept should shed new light on such things as: (1) the appropriate legal form for the cooperative association; (2) the cooperative income tax question; (3) the nature of "non-member" business in the cooperative; (4) the need for "grass-roots" control in the cooperative association; (5) the economic expansion rate for a given cooperative activity; and (6) economic and successful methods of financing cooperative activity.

For example, consider the cooperative income tax question. Whether the joint activity is conducted on a pooling basis, a purchase and sale basis, or on some other basis, it is operated for one purpose—to make their integrated business operations more successful. Theoretically and actually it is impossible in any short run period to determine the exact amount of net income which specifically arises from the operation of the joint plant. The net income is made in and accrues to the *participating firms as integrated production units.* Economically, there is only one accurate way in which the income arising from the joint activity can be taxed; that is to include it as a part of the total taxable income of each of the participating units. This is true whether such earnings are invested to expand the joint plant, whether they are invested to expand the individual plants of the participating firms, or whether some other disposal is made of them. It is true whether the participating units are corporate firms, partnerships, or individual proprietorships.

An understanding of the economic nature of cooperative business activity, as developed here, clearly reveals the absence of scientific basis for such statements as "in the cooperative association *people,* not capital, count," "factories are free to cooperative members," "cooperation is a superior way of doing business," "to the extent that the cooperative is

different from other types of business activity, it is a *social* organization," and "in business, cooperation is the antithesis of competition." Such so called "cooperative principles" as "business with members at market prices" and "one-man one-vote" and "business on a strictly cash basis" are revealed as inaccurate or irrelevant. And, finally, the concept can contribute much toward improved financial structures, improved accounting procedures, and more effective policy decisions within cooperative associations, and it can aid in the formulation of sound public policies as they relate to the cooperative activity.

THE SOCIALIZATION PROCESS IN CZECHOSLOVAK AGRICULTURE[1*]

FRANK MEISSNER
University of California

"We have an obligation to support emerging Unified Agricultural Cooperatives, and help to transfer the existing ones into higher types."
President Klement Gottwald

The Setting

THE land reform in the first Czechoslovak Republic has, no doubt, strengthened the relative position of the small and moderate-sized peasant holding. The number of farms between two and five hectares in size increased by about one-third. Agricultural and forest lands were taken from landed estates of 100 hectares and larger. One has to admit that the major objective of breaking up the large estates and securing wider ownership rights for the peasant has been carried out to a large extent. The Left Wing parties did not, however, consider the reforms to be thoroughgoing enough. Only one-eighth of the land changed hands. The results were disappointing[2]—a watered-down version of the ambitious plans of the 1919 Land Reform Law.

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[1] The first draft of this paper was presented at the agricultural session of the Rotary International in Lodi, California, on August 14, 1952. The writer is greatly indebted to Josef Braza, Editor of *Nas Chov* (Our Livestock Breeder), Prague, who has kindly provided the source material. Thanks are also due to Raymond Bressler, Sidney Hoos, and Guy Black from the Giannini Foundation of Agricultural Economics at the University of California; William Horbaly, Washington, D.C.; Ladislav Feierabend from the Mid-European Studies Center, New York; and Raleigh Barlowe from Michigan State College for having critically reviewed the paper at different stages of development.

[*] Giannini Foundation Paper Number 132.

[2] Dr. Ladislav Feieraband, former Secretary of Agriculture in post-Munich Czechoslovakia and later on in the puppet Cabinet of President Emil Hácha in the Protectorate Bohemia and Moravia; subsequently fled to London to become Secretary of the Treasury in Benes' Exile Government, said in a personal communication to the author (dated September 1, 1952):

"In the introduction to your paper you say that the results of the first land reform were disappointing. I don't want to influence your evaluation, but I think it is not just. The first reform was among the best in the world. There were made mistakes which I would not deny—particularly the interferences of political parties. The reader of your study might have the impression that the Communist-led land reform was better than the first reform."

The reader should thus keep in mind that even though the author's opinion happens to coincide with the views of several American observers, it is not necessarily the general concensus.

Because the dominating Agrarian Party decided the reform to be accomplished, and as the Left Wing never gathered enough votes to force a significant amendment, the issue went underground and became a source of latent dissatisfaction among the small holders and tenants.

After World War II the situation changed considerably. The coalition government[3] of Czechoslovakia, by decree of the late president, Edward Benes, confiscated all agricultural property owned by traitors of German and Hungarian nationality.[4]

Approximately three million hectares, or about one-fifth of the entire area of postwar Czechoslovakia, were suddenly available for settlement by Czech and Slovak nationals. Most of the farms were quite small. Better than half of all the land was located in the mountainous border regions (Sudetenland).

Then and there the Communists assured for themselves the Secretariat of Agriculture. It was a position of tremendous strategic importance which would allow Communists to see to it that this time the land reform would be carried out, not only to the letter but also in the spirit of the law. Although all political parties officially supported the provisions of the presidential decree, the Communists let it appear that they were the only real benefactors of the small holders and landless proletariat. They were to distribute the land to World War II veterans, farm wage workers from the central districts of Bohemia and Moravia, and migratory labor from Slovakia. A large campaign was started, under Communist auspices, to make Czech and Slovak nationals settled abroad return to their homeland. The land would be owned only by people who work it.[5] Absentee landlords could henceforth not be tolerated.

The value of at least one average crop, at most two average harvests, was the payment which the government asked for the allotments to the new owners. It was a something-for-practically-nothing proposition. No time was wasted in distributing the available land. By October, 1945, six months after liberation, over 70 per cent was allotted, 60 per cent went to former hired farm laborers, 40 per cent to small holders. No wonder that the last free elections in 1946 returned the Communists with over 35 per cent of the popular vote.

The extension of the 1919 Land Reform Law was finally passed in

[3] All major political parties were represented in the Cabinet.

[4] Similar developments were encountered in other satellite countries and are described in: L. D. Schweng, "Recent Agricultural Development in Eastern Europe," *This Journal*, February, 1951, pp. 40-54, and Petrovich, M. B. "Some of the Problems of Land Tenure in Eastern Europe," *Land Economics*, February, 1952, pp. 30-36.

[5] "Article XII. 1. The economic system of the Czechoslovak Republic rests . . . on the ownership of the land in accordance with the principle 'The land belongs to those who till it.'" Fundamental Articles of the Czechoslovak Constitution of June 9, 1948.

Spring 1947, Julius Duris, the Communist Secretary of Agriculture, was ready for the *coup d'état.*

The Communists Take Over

In February, 1948, the Communist regime firmly established their control of the government. The socialization process was ready to start. With the sad Russian experience of collectivization in mind, Secretary Duris was cautiously feeling his way around. Czechoslovakian economy was now to be fully state planned. Controlled capitalist principles of guidance were to be discarded. The farmer as an individual operator was to be eliminated.

Rudolf Slansky established the ramifications of the program:

"The party acknowledged that the greatest task that lies in the path to socialism is the conversion of the rural areas. It is a problem more difficult than the conversion of industry. In industry we deal with a relatively small number of capitalists and a large class of industrial workers, who are strongly in favor of nationalized industry. In agriculture we deal with a much larger class of rural capitalists and literally hundreds of thousands of small producers. Besides being working people these farmers are private owners. They have many prejudices against socialism. They resist changes. That is the reason why the gaining of the village for socialism is so complicated and difficult a task. We have one great advantage, however—the experience of the Soviet Union and its famous All-Union Communist Party which has shown us the way to solve this problem."[6]

The socialization process was to be a slow ordeal by degrees. The main tools of torture are the four types of Unified Agricultural Cooperatives plus land ameliorization; taxation; production and marketing programs; and mechanization.[7]

Unified Agricultural Cooperatives (UAC)

Traditions of successful cooperative enterprises in Czechoslovak agriculture go back to 1848. This the Communists knew only too well. But they did not like the fact that the diversified village processing, purchasing, or service cooperatives were operating independently under separate

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[6] Rudolf Slansky, the now liquidated Secretary-General of the Czechoslovak Communist Party (CCP): "Unified Agricultural Cooperatives and the Aims of the Party in the Village." Speech read at the February 24, 1950, session of the Central Committee of the CCP. All Slansky quotations are from this particular reference.

[7] Readers interested in more detailed background information should consult the following references: Stanley Mehr, "The Farmer and His Land in Communist Czechoslovakia." *Foreign Agriculture,* U. S. Office of Foreign Agricultural Relations, Vol. XIV, No. 7, July, 1950, pp. 156-160. Antonin Basch, "Land Reform in Czechoslovakia" in Ackerman and Harris, *Family Farm Policy,* University of Chicago Press, 1947. Raleigh Barlowe, "Land Tenure in Czechoslovakia." *World Land Tenure Problems Conference.* (Proceedings.) Part 4. Handbook of References. Madison, Wisconsin, 1951. (Volume not page numbered.)

boards of directors. Such a setup does not lend itself to centralized control.

The Unified Agricultural Cooperative movement was therefore launched under the disguise of gain in efficiency. Increased productivity was no doubt an important motivation for consolidation. Splitting up the large estates, which as a whole farmed rather efficiently, created holdings too small for mechanization. Also, many of the farmers who settled the vacant land in the Sudeten border districts, were not very well qualified to manage their own places. These included many of the former hired and migrant farm laborers plus a great number of entirely unqualified opportunists. Production goals of the agricultural sector were as yet practically never fulfilled. This obviously created serious bottlenecks, which threatened the success, first of the Two Years Plan (Dvouletka) and presently of the Five Years Plan (Petiletka).[8]

The official responsibility of the difficulties was laid on the shoulders of capitalist reactionaries, village rich, and other enemies of the people. The UAC were proclaimed the only effective means of stopping the saboteurs.[9]

The UACs were divided into four types according to the severity or extent of socialization:

Type I entails farmers cooperative associations as we know them in the Western countries. All existing farm co-ops were automatically ranging under Type I. No model bylaws or new interpretations were required.

Type II carries out collectively all field work. The boundaries between individual fields can remain untouched. An average yield per acre is computed, and the crop is prorated to the participants according to their acreage contribution.

Type III requires complete consolidation of land, plus sale of machinery, seed, and supplies, as well as livestock to the association. The cooperative pays a rent for the utilization of the land. The member retains his private residence, a garden plot, and some few head of livestock.

Type IV is, for all practical purposes, a prototype of a Soviet Kolhoz. By turning over his land to the UAC, the member forfeits, except for the inheritance right, his fee simple. Proceeds are divided exclusively on the basis of labor units contributed by the individual members.

No matter how many or how few farmers join a UAC, it immediately becomes the sole spokesman on agricultural matters for the whole com-

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[8] The Five-Year Plan introduced in 1949 covers the period, January 1, 1949, to December 31, 1953. It aims at increasing agricultural production by 37 per cent over the 1948 level and by 16 per cent over that of 1938. (At the end of the 1947-48 Two-Year Plan, the production was still approximately one-fifth lower than in 1938. This fact was due to population and territory loss, war damages, and land reform unrest.) The Plan also emphasizes a shift away from cash grain crops to increased production of livestock and more intensive root crop and forage cultivation.

[9] For general description of the process of creating a UAC as well as eight detailed case studies consult: William Horbaly, "Agricultural Conditions in Czechoslovakia, 1950," Department of Geography, University of Chicago, Research Paper #18, June, 1951.

munity. All other cooperatives and their membership are automatically taken over by the UAC. Type IV is the ultimate goal of the Communist Party. The stages I to III are officially frowned upon. They are temporary concessions to the stubborn conservatism of the "capitalism-smitten" small and medium farmer.

Let us analyze the important structural features of Types II, III and IV.[10]

Type II

Type II does not entail a mandatory land consolidation. In fact, it is not even necessary to own a minimum amount of land to become a member of a UAC. Neither is it required to enter all land which an individual member owns. These provisions are to facilitate an infiltration of the organization by industrial workers who live in villages. They most often are part-time farmers and extremely reliable Party members. The Communist leaders do, with amazing frankness, emphasize this spying and controlling task of the miner-farmers or metal-farmers.

Slansky pointed this out: "Our main support in the villages are the industrial and agricultural workers, and the small farmers . . . many of our comrades are mistaken about these small agriculturists who at the same time are working in industry. They believe that a factory job would not provide the worker with genuine interest in the cooperatives. The fact is that there are sufficiently many industry workers living in villages so as to be the most reliable Party aides in rural areas. All industrial laborers, who live in villages and are members of the Party, *must* take part in the local organizations and *must* be the most active leaders in the building of socialism in agriculture."

The larger commercial farmers are a very handy scapegoat for all grievances and troubles occurring in already established UAC's. According to Slansky: "The UAC must be guarded from the influence of the village rich. We still have frequent cases where the village rich join the cooperative. Sometimes they even take initiative for its formation or influence the board of directors. They don't intend to make the cooperative benefit the small and medium holder. They join merely for their own benefit. They want the advantages of less expensive seeds, fertilizers, tax exemptions, use of machinery. They want to protect themselves against

[10] The material is based on an official set of model bylaws issued by the Czechoslovak Department of Agriculture in January, 1952:
(1) Rad spolecneho obdelavani pudy II typ—JZD Cerenice.
(Procedure of cooperative field work type II—UAC Cerenice) p. 13.
(2) Rad spolecneho hospodareni III typ—JZD Prikazy.
(Procedure of cooperative farming type III—UAC Prikazy) p. 22.
(3) Rad spolecneho hospodareni IV typ—JZD Prestavlky p. 22.
(4) Rad spolecneho hospodareni IV typ—JZD Redhost p. 22.
The above mentioned literature will be referred to as: Model Bylaws, and their respective numbers.

increased commodity delivery obligations (quotas). They want the other members of the cooperative to cultivate their fields inexpensively. In those cooperatives where difficulties have occurred, the rich lead the opposition to collective field work. They try to destroy the cooperative from within. It is therefore necessary to expose this destructive work of the village rich, to purge the UAC's of this class enemy."

To paraphrase: Any time there is trouble, just blame it onto sabotage by the village rich and everything will be all right.

Resistance to the formation of Type II UAC's is common. The farmers know that once a Type II cooperative is started, it becomes only a question of time until it is transferred into Type III and finally into Type IV. The opposition, however, is to no avail. It takes "legally" only five residents, who in fact might be industrial workers, to start a UAC. The Party admits openly that this five-person clause was instituted so as to combat the hostile attitude of the reactionary majority in the village.

Typically the *Farm Adviser* journal carried a case description of how one particular UAC proceeded in hostile surroundings: "The enemies of UAC asked all people to attend the meeting of the Village Council. They thought that they were going to vote on whether there would be a UAC in the village or not. They were sadly mistaken. Nobody asked for their opinion. The UAC was started . . ."[11]

Operation costs in a Type II UAC are divided into two categories: (1) labor and (2) land.

(1) The labor which members perform on the UAC lands is paid according to norms agreed upon by the membership assembly. The UAC, so to speak, hires its own members to work for it.

(2) Costs of labor contributed, custom charges for work performed by State Tractor Stations, hired management, plus seeds and fertilizers are the main items of land cultivation and harvesting expenses.

Returns to the members are again divided into: (1) labor and (2) land categories.

(1) Each member has an obligation to contribute as much labor as the cooperative management deems necessary. Wages are determined by a scale based on how relatively difficult, complicated, or important the different work categories are.

(2) The distribution of returns accrued to land is usually the main point of dispute. The difficulty seems to rest in the clause of the model bylaws saying: "The board of directors computes the *average* yield per acre in all crops covered by membership contract. Each member's share is determined by the amount of land contributed to the UAC," This, again, is a clever "leveling out" device. The farmer with the best quality land con-

[11] Hosek Vaclav "Jak budujeme JZD . . ." ("How We Build a UAC . . .,") *Radce Zemedelce* (Farm Adviser) #135; 1950; p. 12.

tributes a disproportionately high share to the costs, and receives a disproportionately small share of the returns. The government commodity delivery quotas are handled by the UAC on behalf of its membership. An attempt is being made to settle all accounts one month after all crops are gathered in. Except for the management planning, the Type II UAC is "dormant" during the winter.

Type III

A. *Factors of Production*

Land—All land of the individual is left in charge of the UAC for the time of the membership duration. The land is subject to inheritance.

Vegetable gardens and orchards, retained for personal use of the member, should not be larger than about one and one-fifth acres (0.5 hectares). This severe limit is a result of adverse Russian experiences, where Kolhoz members tended to spend too much time working their own lots and thus were apt to neglect the work on the cooperative lands.

The crop from UAC lands is owned by the UAC.

Membership, once acquired, is mandatory for a period of at least three years. If a member wants to leave the UAC, the board of directors has to be notified at least six months prior to grain harvest. A "divorce" is, of course, discouraged. Although the land is being returned, it is not necessarily the land which the individual originally has contributed. The UAC can maintain that to return this particular acreage would disturb the consolidation pattern or the established crop rotation. The "divorcee" has thus to be satisfied with whatever land the UAC can spare.

Livestock and Other Inventory—All draft animals and registered livestock have to be turned over into the custody of the UAC.[12] Each member family can retain one cow and calf, one sow, three fattening hogs, sheep, goats, poultry, rabbits, and bees.

As for tools and machinery, the clause is broad enough to cover all degrees from nothing to practically everything a member owns: "The UAC takes over all the inventory which is *necessary for a successful operation.*" Buildings, which the member does not need for housing his livestock and feeds, are also taken over by the cooperative. Residential buildings are retained by the members. No obligations are attached to this private property.

The UAC pays cash on delivery for bred cows, heifers, sows and ewes, rams and boars. The price is "general" without any further classification of the term. All other livestock (horses, oxen, steers, dairy cows, etc.) are credited to the member in the association's books. Twenty per cent of the amount is put into an obligatory reserve fund of the UAC. The remaining

[12] In order that a commodity delivery quota can be assigned, all farmers have to register their livestock inventories with the local authorities. This registration has been compulsory to all farmers since about 1940.

80 per cent is considered a free investment loan (carries no interest), which "will be paid off, when and if possible."

Similar regulations also apply for other inventory.

If an individual cancels his membership or is expelled, "The cooperative returns his livestock and other inventory in intervals, the length of which will be determined by the general assembly."

B. *Management*

The Board of Directors makes contracts with: (1) the State for an overall Commodity Delivery Quota, and (2) the State Tractor Station for custom machinery work. The Board, in cooperation with the farm adviser (agronom) at the local State Tractor Station, will work out a production plan and budget. These decisions are subject to approval of the General Assembly of the membership. There are regular monthly meetings, but emergency or special meetings can be called at any time the Board deems it necessary.

A special Board of Supervisors is elected with the task of constantly controlling the progress of the work and the management of finances.

The UAC has an obligation to utilize the best available farming methods. This implies crop rotation, commercial fertilizer application according to soil test indications, weed and parasite control, certified seeds, moisture preservation, membership in a Dairy Herd Improvement Association, and "above all, to fully utilize and apply the methods and the rich experiences of Soviet Kolhoz farms, so as to realize, as completely as possible, the principles and aims of a socialistic agricultural cooperative."

C. *Organization of Work*

Each member has an obligation to be at the disposal of the UAC for at least 100 working units a year and is assigned a minimum schedule which distributes his work throughout the different rush seasons of the year.[13] The members do have an obligation to work 10 or more hours a day if deemed necessary during labor peak periods.

Part-time members can be exempted from the different labor minima, subject to Membership Assembly approval.

No hired labor is used, except for highly skilled craftsmen doing work which none of the members can perform. All labor is done on piecework basis.

Members are divided into permanent gangs or groups according to the work they perform (livestock tending, field work). Every group is headed

[13] A working unit is the credit which each member gets for his work. There are seven classifications (from one-half unit with one-fourth unit intervals to two units per day equivalent) determined by the difficulty, complication, and importance of the task. The norms can be amended any time if and when found unjust or for other reasons unsatisfactory.

by an elected supervisor, who each morning, in the presence of the Board of Directors, receives instructions from the UAC manager. The group supervisor discusses the work with his group before assigning tasks to individual members. He is responsible for the quality and punctuality of performance of the group.

Members can be given advances in cash or kind up to 50 per cent of the value of work units performed. Perquisites include roughage for the privately owned livestock. The working groups are encouraged to compete among each other on local as well as nation-wide scale. The performances of each member are recorded on a public blackboard and brought up to date each month.

D. *Social Welfare*

The Cooperative will pay for technical schooling of members with special abilities if the UAC finds the development of these talents useful. The cultural level of all individuals should be enhanced by lectures, amateur theater, excursions, libraries, discussion groups, adult education, and political indoctrination. The social fund is partially used for health insurance premiums covering all members, for sport facilities and contest participations, and a day nursery for working mothers.

E. *Distribution of Income*

The input of labor units is the main basis for each member's reward. The payment is made in cash as well as kind.[14] Before the net cash return is distributed, from 10 to 20 per cent is taken out to pay "rent" and/or ammortization for the acreage contributed by the individual members.

Money for improvement and new investments is held in a reserve fund which cannot be divided among the members. If the funds should not be sufficient, additional means can be borrowed from Mutual Farm Finance Associations. To encourage and facilitate the growth of UAC's, a general income tax exemption was granted to all Unified Agricultural Cooperatives of Type III and IV for the period from and including the day of incorporation to December 31, 1953.[15]

Type IV

The model bylaws of Type IV differ only on two points from Type III. They are, so to speak, essentially Type III: only more so.

(1) The minimum labor unit inputs are increased from 100 to 120 per year.

(2) The fee simple vested in the land is turned over to the co-op, similarly as in Type III, while inheritance rights are retained by the farmer. But there is no remuneration for the land contributed—either in

[14] For an explanation of UAC accounting techniques and derivation of rates of return, the reader is referred to detailed case studies in Horbaly, *op. cit.*, pp. 64-83.

[15] *Interagra*, Vol. V, Nos. 3-5, 1951, p. 303.

the form of rent or in form of any ammortization. Except for the payments still made for the different classes of livestock contributed, Type IV is an exact prototype of the Russian Kolhoz, and thus the eventual goal of the Communist regime of Czechoslovakia.[16]

Summary

Thirty-five years of Soviet Russian Collectivization experience have helped to form the approach of the Czechoslovak Communist Party to the socialization problem of Czech agriculture. The process was to be one of more or less kind persuasion, an easing into the strait jacket of kolhoz farming.

The strategy entailed:

A. Promises of land to landless hired and migratory workers, tenants and small holders. These promises were easily lived up to since considerable acreage was confiscated from the expelled German minority. The Communist Party emerged from the 1946 elections with 36 per cent of the popular vote, a considerable part of which originated in rural areas.

B. After the overthrow of the government in February, 1948, a thorough land reform was enforced. Large and medium land holdings, church lands, and lands of persons not in sympathy with the regime were confiscated. Some of the land was set aside for state farms and other public utilizations. The balance was broken up into small units—often without buildings, livestock, or equipment—for distribution to the landless peasantry. These new units were frequently too small to really insure the cultivator a subsistence, or enable him to fulfill government commodity delivery quotas. Nor had many operators the necessary qualifications for management of their own enterprises.

C. A great crusade against these alleged inefficiencies followed: "From the uneconomical small enterprise we transfer to cooperative farming. This facilitates a better utilization of all the advances of agricultural science and technique. We enhance yields, fertility, productivity of labor, decrease production costs, and make use of economies of scale. Thus, we enter the path of Soviet Kolhoz workers, the most progressive farmers in the world, who are our great example. From them we will be constantly deriving rich experience, so useful in developing our socialistic village."

"Through the realization of these measures, by a ruthless and consistent struggle against the village rich, exploiters and enemies of the people, we will ensure a steady increase in the level of living for the members of our cooperatives, and, at the same time, we will enhance the general welfare of the entire labor class."[17]

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[16] Soviet State and Law, November 7, 1950: "The peasants of the peoples' democracies, uniting in producer cooperatives, are beginning to voluntarily renounce the unearned income—ground rent" (the farmer's share in the profit based on his contribution of land to the UAC). This action will transform the co-ops "from undeveloped social establishments of incomplete form into developed socialist farms."

[17] *Model Bylaws*, No. 3, p. 5.

The ordeal of socialization is proceeding through four degrees or types of Unified Agricultural Cooperatives. Often genuine cooperatives, which traditionally have performed marketing, processing, purchasing, and service functions, are seized and used as a basis for the new type of cooperatives. The principles of voluntary democratic participation are virtually perverted.

Farmers who do not join find that they are discriminated against by higher taxes,[18] stiffer delivery quotas, lacking supply of fertilizers, equipment, consumer goods, and credit facilities. For the most stubborn individualists, who never seem to be convinced of the advantages of "cooperative" farming, outright coercion is used.

Under the "mild" Types II and III, profits are distributed according to not only labor, but also resource contributions. The UAC pays a kind of rent for the land utilization. But these are only stations to be passed on the way to Calvary—Type IV, the full-fledged collective stage. The farmer is no longer paid for the land. His share in the rent becomes the property of the UAC. By virtue of the crucial dependency on the State Tractor Stations, Type IV is for all practical purposes government controlled. Although the member is permitted to keep his home and garden plot, he assumes in effect the status of a landless laborer. The vicious circle is closed.

In conclusion, a few statistics: In 1947, the last pre-Communist year, about 30 cooperative farms were in existence. In December, 1951, the number was 6,250 (Types II, III, and IV). This means that every second village already operates under a UAC. In 1951 alone, 1,011 UAC's were founded; 1,507 were under preparation. The number of Type III co-ops increased by 1,070; Type IV, by 106. In 1951, Types II, III, and IV contained 17.2 per cent of the total acreage in crops. The socialistic sector (including state farms) covered 30.6 per cent of the total farm land of Czechoslovakia[19] and owned 20 per cent of the country's livestock.[20]

Considering the rugged individualism of the Czech farmer and the fact that this extensive socialism still permitted a 90 per cent fulfillment of the agricultural production plans, one must admit that, somehow or another, the Czechoslovak Communist Party has so far been "successful" in its bid for socialized farming. Evidence of a free and independent Czech farmer, at least in the Western sense of the words, will, however, before long be found only in history books.

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[18] One of the most important sources of state revenue is the indirect sales tax collected on sales of all goods and services. Farmers pay this tax only for commodities consumed on their own farms. In order to further a speedy introduction of the higher type collectivization, UAC's of types III and IV are exempted from this tax. (Czechoslovak Law No. 283 of 1948 and amendments.)

[19] *Interagra*, Vol. VI, No. 7, 1952, p. 12.

[20] *For a Lasting Peace, For a People's Democracy*, Prague, August 10, 1951.

SHORT-RUN EFFECTS OF INCOME CHANGE ON EXPENDITURE

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THIS paper discusses the short run or immediate response of the household to changes in income. The analysis presents new findings on income elasticity in the short run having important implications for public policy. Two measurements were made to discover the leads and lags in expenditure associated with income change. First, an attempt was made to determine how changes in savings were related to income payments. Second, an attempt was made to determine how household expenditures for various types of consumer goods varied when income changes occurred. Particular attention was given to fluid milk and groceries to determine how income fluctuations affected the demand for agricultural commodities.

Methodology

A single New England community was the source of data for these measurements. The sample period included 1947, 1948, and half of 1949. This particular community was selected because: (1) it was well isolated, (2) a small number of firms employed most of the wage earners in the community, and (3) the payrolls of these firms were subject to wide variation. Pay roll, sales, and bank balance figures were obtained directly from firms for each week of the period. These were used in estimating total income payments, expenditure on individual commodities, savings balances, and changes in savings balances or net saving.

A single community was studied, rather than the nation as a whole, because it was believed that income changes (in this community) had no significant effect on retail prices. Aggregative data for the community were used rather than data for a sample of households because the expenditure decisions of the household may be formed in such a manner that a budget type study would not measure the impact of an income change on expenditure. If expectations of the households are influenced

* This paper is based on the author's Ph.D. dissertation, "Short Run Income-Expenditure Relationships," which was submitted to the University of Chicago in 1952. Appreciation is expressed for the assistance and help given by several colleagues, particularly Milton Friedman, the chairman of my dissertation committee; Hazel Kyrk, O. H. Brownlee and Clifford Hildreth who served on the committee; D. Gale Johnson and T. W. Schultz whose advice was obtained during the early stages of the study; Harold Halcrow who read the entire thesis and made many helpful suggestions; Stewart Johnson, George Judge, and Richard King.

by the level of payrolls of the major firms in the community, shifts in income use by a particular family may occur when aggregate income payments change, even though the income of that particular family does not. This relationship between aggregate income payment and expenditure would also be present if the household attempted to maintain its relative expenditure position. Effects on expenditure of this type of consumer behavior would not be observed in the usual budget type study. The data obtained from community aggregates were preferred to any other data which could have been obtained at the same cost.

Savings Balances and Income Payments. First, measurements were made to test the hypothesis that instability would be found in the income elasticity of demand for all expenditure if measured at various points in time following income change. Estimates were made of the linear relationships (1) between income payments and savings balances and (2) between income payments and the net amount saved. These estimates were made by fitting payrolls to bank balances and by fitting payrolls to changes in bank balances. Comparison of the two correlation coefficients followed to determine the degree of stability in the consumption function. Additionally, the bank balance data were examined in an effort to isolate the factors causing the variations in these balances.

Estimates of savings balances and changes in savings balances, or net saving, were derived from time deposits of the commercial bank in the community. Estimates of demand deposits in the commercial bank were excluded from the calculations because these accounts largely reflected the transactions of firms rather than households. The evidence that was available suggested a positive correlation between bank balances and the "M" of the quantity equations and between changes in bank balances and the "S" of the savings-investment theory. No evidence was found of a negative correlation between bank balances and "M" or between changes in bank balances and "S."

Expenditures and Income Payments. Second, a direct approach was used in which income elasticities were calculated for several short periods. Comparisons then were made among the several elasticities to determine if they were significantly different.

The sales records of 10 firms were used to estimate the purchase of goods by the persons whose incomes were estimated. Weekly sales data were obtained from two dairies, three grocery stores, and five apparel goods stores. Sales data from some other stores were obtained for a part of the sample period. These data suggested that all firms in the community selling the same groups of commodities experienced similar changes in business.

The analysis of the income and expenditure data consisted of fitting linear regressions to the data for (1) the six month periods within the two

and one-half year period and, (2) the two and one-half year period. The income elasticities were then calculated at the means. Seasonally adjusted elasticities were calculated for all items except fluid milk by converting the income and sales data to the ratios of the corresponding week of the preceding year. Quantitative estimates of the seasonal components in the original observations were calculated from the several regressions.[1] The data, with the exception of that on apparel goods, were adjusted for price changes and additional elasticities were calculated. An additional set of elasticity estimates were made by converting the seasonally adjusted data to logs and fitting linear regressions.

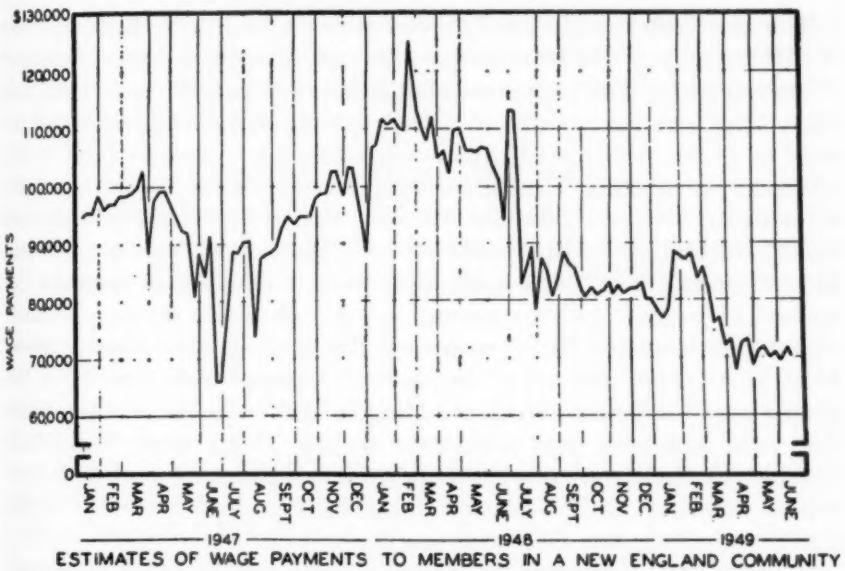

FIGURE 1

Estimate of Total Income Payments

Income payments received by all members of the New England community were estimated for each week of the two and one-half year sample period. The payroll records of the largest firms, which employed about half of the wage earners in the community, were used to estimate the incomes of this group of the population. The mean of these income payments amounted to about $90,000 per week. The variation in these wage payments is indicated in Fig. 1.

All other income payments received by members of the community were considered stable and equal to $90,000 a week during the sample period. These payments consisted largely of wages paid by local stores, gas sta-

[1] See Appendix for method used.

tions, banks and several units of the government. Thus, total income payments for each week were estimated to be the wage payments of the largest employers plus $90,000. This estimate of total income payments undoubtedly contained an element of error. Error in this estimate resulted from the problems of dating income payments, weighting payrolls to exclude payments to members of other communities, and the absence of data. However, these problems did not seem to be major obstacles because a high per cent of variation in income payments was accurately determined.

Findings on Income Payments and Savings Balances

The correlation coefficient between payrolls and bank balances was + .79 but only + .18 between payrolls and changes in bank balances.[2]

Interpretation. The higher correlation between payrolls and bank balances than between payrolls and changes in bank balances indicated instability in the income elasticity of demand for all expenditure and in the consumption function. The difference in the correlation coefficients indicates that a stable relationship existed between a person's income and amount of savings on hand rather than between a person's income and the net amount saved each week. Had stability been found between the amount of payrolls and the amount saved each week, savings balances would have increased during each week that payrolls were above a given level. These people did not act in this way. When payrolls were high, the people were sometimes saving or adding to bank balances; at other times they were decreasing bank balances or savings. These people maintained a stable relationship between their payrolls and the amount of their time deposit balances. In this respect, these findings lend credence to the Pigouvian rather than the Keynesian analysis of income determination.[3]

Consideration of Seasonality. There is little possibility that a seasonal factor in payrolls and/or savings was responsible for the difference in the correlation coefficients between payrolls and bank balances compared with payrolls and changes in bank balances. First, assume that the pattern in bank balances resulted from a bank balance seasonal which was independent of payrolls. If such a seasonal was present in the bank balances held by the local bank, a similar pattern of bank balances likely would have been found for other banks in the area. Since this bank was located in New England, figures on time deposit balances in District I reporting member banks were obtained from the Federal Reserve Bank in Boston.

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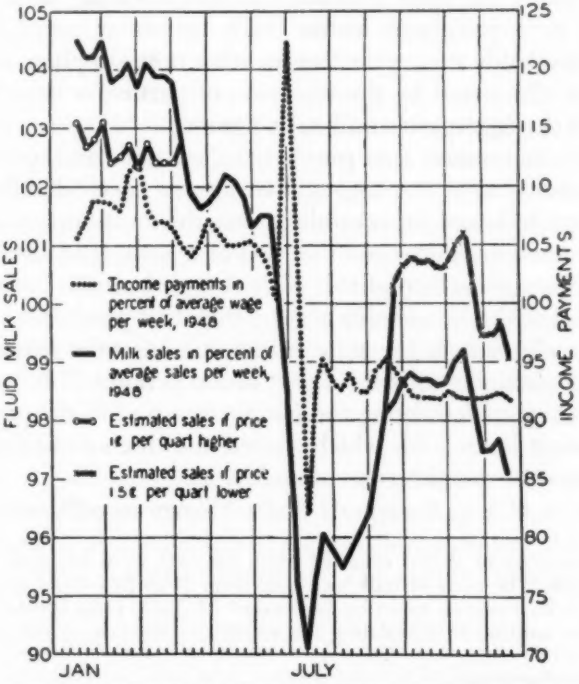
[2] A t value of 6.92 was obtained when these correlation coefficients were tested to determine if they were significantly different. The one per cent critical value of $t = 2.596$ with 252 degrees of freedom. Therefore the hypothesis of no difference in the correlation coefficients will be rejected.

[3] For a more complete discussion of this point see writer's article, "Income, Savings Balances, and Net Saving," in a forthcoming issue of *The Review of Economics and Statistics.*

These figures did not reveal the presence of such a seasonal factor. Second, assume a seasonal factor in payrolls with a secondary effect determining changes in the balances held by the local bank. A unique pattern in the balances of the local bank would have been expected if it was a result of a true seasonal change in payrolls and if the household attempted to maintain expenditure at a constant rate throughout the year. Bank balances, under these circumstances, would be increasing only and at all times when payrolls were above the annual average and would be decreasing only and at all times when payrolls were below the annual average. Peak bank balances would be recorded following a period of high payrolls and on the date payrolls fell to the annual average. A trough of bank balances would be reached following a period of low payrolls and on the date when payrolls increased to the annual average. Inspection of the payroll and bank balance data indicated that the peaks and troughs of payrolls and bank balances coincided.

Findings on Various Commodities

Fluid Milk. The households purchased significantly different amounts of fluid milk within the first few weeks compared with the later period following the major income decrease which occurred in the summer of



INDICES OF FLUID MILK SALES AND INCOME PAYMENTS IN A NEW ENGLAND COMMUNITY, 1948

FIGURE 2

1948. The following income elasticities and 95 per cent confidence limits were calculated:[4]

1. .24 ±.08 (period of January 17 through December 25, 1948)
2. .46 ±.06 (period of May 1 through September 25, 1948)

The relationship between income payments and fluid milk sales can be examined in greater detail by an inspection of Fig. 2.

Interpretation: Inspection of Fig. 2 suggests that the amount of fluid milk purchased was smaller immediately after the income decrease than at a later date. The pattern of fluid milk purchases associated with this income decrease was interpreted as falling into three stages. The first stage was characterized by the purchase of less milk than during later stages and by a greater decrease in purchases than would be expected on the basis of elasticity estimates presented in other studies. The second stage was characterized by increased purchases following the decrease which occurred in the first stage. A third stage was recognized in which fluid milk purchases tended to level off at a rate lower than before the income decrease, and more than in the last part of the first stage.

Factors Affecting Milk Sales: An explanation of this pattern of fluid milk sales must run in terms of the effects of income change and/or other factors. Probably the most important factors affecting milk sales during this period were price and season. Such factors as population change, shifts by households among dealers for their milk supplies, and vacations were largely eliminated by the exclusion of particular household groups in compiling the aggregative milk sales figures.

Only those households that purchased fluid milk during each week of 1948 were included in the aggregative figures on total milk sales. This procedure was followed for several reasons, the most important being that the dealer sometimes destroyed the card of a household discontinuing its purchases. Since some households shifted their business from one dealer to another, all of the households making their first purchases after January 4, 1948 were eliminated. Likewise, all households were eliminated which discontinued obtaining milk for a part of the period.[5] This procedure had the disadvantage of restricting the sample to a part of the population but eliminated most households which started and discontinued the purchase of milk because of vacations and other factors.[6]

Examination of Fig. 2 suggests that a change in milk price was not a

[4] A price elasticity of .3 was assumed when the data were adjusted for changes in the price of milk. The price of milk increased from 21 to 22 cents a quart on April 1, and from 22 to 23.5 cents a quart on September 16, 1948. Data for the weeks of July 3 and 10 were omitted in calculating the elasticities because of the vacation bonus payment.

[5] Four deliveries or more.

[6] If these households had not been eliminated, the figures would have indicated a greater decrease in milk purchases during the summer months than was indicated by the figures as calculated.

major factor. Adjustment of the milk purchase data for changes in the price of milk was not responsible for the pattern found in the purchase of fluid milk, nor did the adjustment appear to significantly effect the pattern of the relationship between milk sales and income payments.

Effect of seasonality on milk purchases in this community during 1948 was difficult to estimate. Study of seasonal variations in milk purchased in nearby New England markets provides no basis for concluding that the pattern of purchases in milk sales was not significantly affected by the season. However, since milk sales in this New England community excluded sales to schools, factories, stores, eating places, and to households not buying in each week of the year, most elements in the seasonal variation in sales had been removed.[7] Thus, it seemed unlikely that the difference among the elasticity magnitudes were due to seasonality in milk consumption. For example, if milk sales to schools were included, milk sales in the summer months would have been lower relative to the winter months than was indicated by the figures on milk sales which were used in calculating the elasticity estimates.

A note of caution at this point. No evidence was obtained which can be interpreted as conclusively excluding explanation of the relationships found between the estimates of income payments and milk sales in terms of seasonality, vacations, and other factors.

Groceries, Apparel Goods, and Total Expenditure. Calculations were made of the income elasticity of demand for groceries, apparel goods, and total expenditure.[8] The elasticity estimates presented in Table 1 were calculated from the weekly data for the two and one-half year period.

The short-period elasticities which were calculated for six-month periods were characterized by relatively wide confidence limits which prohibited detailed generalizations about expenditure adjustment patterns followed by the household in the purchase of these commodities.

Interpretation: Examination of Table I indicates that (1) the seasonally adjusted estimates (Column 3) are not far out of line with comparable elasticities reported elsewhere, (2) the adjustment of the data for seasonality removed an important source of variation, (3) the elasticity estimates were not improved by adjusting the data for price changes or by converting the data to logs.

Seasonality: The quantitative importance of seasonality as calculated was greater than that of other factors. The variance of the seasonal component in income payments amounted to 138 per cent of the variance of seasonally adjusted income payments. The corresponding percentages

[7] The store price of milk was the same as the home-delivered price.

[8] The income elasticity of demand for total expenditure was calculated from total sales and the savings data. Total sales were assumed to be the sum of all grocery store items, men's clothing, all shoes, and variety store goods. Total expenditure during a given week was estimated from the savings data by subtracting the change in bank balance multiplied by two from payrolls plus $90,000.

TABLE 1. LONG-PERIOD INCOME ELASTICITIES CALCULATED IN SEVERAL WAYS FOR TOTAL EXPENDITURE FOR GROCERY AND APPAREL ITEMS IN A NEW ENGLAND COMMUNITY, 1947, 1948, AND HALF OF 1949*

Commodity	No Adjustment for Price Change			Adjusted for Price Changes	
	No Adjustment for Seasonality	Adjusted for Seasonality	Adjusted for Seasonality and Converted to Logs	No Adjustment for Seasonality	Adjusted for Seasonality
(1)	(2)	(3)	(4)	(5)	(6)
1. Fresh Meats	+.30± .22	+.46±.16	+.32± .16	+.27±.19	+.30±.20
2. Fresh Fruits and Vegetables	+.14± .42	+.16±.25	+.56± .24	+.03±.33	+.44±.35
3. Groceries	+.20± .15	+.56±.11	+.43± .10	+.01±.10	+.44±.13
4. All Grocery Store Items	+.25± .15	+.51±.11	+.38± .10	+.10±.12	+.37±.16
5. Women's Clothing	+1.51±1.01	+2.92±.98	+2.99±1.12	—	—
6. Men's Clothing	+.38± .85	+.80±.79	+.99± .70	—	—
7. Medium Priced Shoes	−.90± .96	+.32±.26	+.43± .68	—	—
8. Low Priced Shoes	−.60± .91	+.20±.50	+.18± .24	—	—
9. Variety Store Goods	+.16± .82	+.38±.33	+.84±1.23	—	—
10. Total Expenditures (Sales)	+.17± .27	+.49±.13	+.55± .14	—	—
11. Total Expenditures (Savings)	+.62± .36	+.93±.32	+.87± .33	—	—

* All confidence limits calculated at 95 per cent level.

were 502 for fresh meats, 764 for fresh fruits and vegetables, 355 for groceries, 409 for all grocery items, 509 for women's clothing, 382 for men's clothing, 425 for medium priced shoes, 1358 for low priced shoes, and 93 for variety goods. Thus, it appeared that the seasonal factor was by far the most important source of variation affecting the sales of these items.

Conclusions

This study suggests that the adverse effect on general welfare of income fluctuations is of greater magnitude than is indicated by economic analysis that assumes either a simple lagged expenditure adjustment to income change or a stable consumption function. This conclusion follows as a matter of logic if:

1. The findings of the study are accepted
2. Firm and household efficiency are negatively correlated with price instability.

The implication for policy is that income stabilization measures are to be recommended for general welfare considerations as well as for the interest of the particular group that is directly affected.

Income Change and Price Instability. This study suggests that house-

holds amplified rather than dampened the effects of income change on the purchase of goods and services. The pattern found in the purchase of fluid milk provides an illustration of the effects of an income change on the demand for a specific commodity, showing how the household amplified the effects of income change. This pattern of purchases was inconsistent with a stable milk consumption function and with a simple lagged expenditure adjustment by the household. The pattern found in the purchase of fluid milk is consistent with stability in savings balances. Moreover, this type of pattern would be expected for at least a few commodities (a) if some expenditure items such as rent and installment buying could not be reduced in a short period, and (b) if the decrease in savings balances was insufficient to cover expenditures on the rigid expenditure items such as rent.

Note is taken that the price variation associated with income change will be greater in an economy characterized by stability in savings balances than in an economy characterized by stability in the level and slope of the consumption function. The manner in which income fluctuations bring about greater price instability in the presence of stable savings balances than in the presence of a stable consumption function is as follows. Demand for all goods and services are greater if consumers spend their entire income increase (which occurs after savings balances reach the new equilibrium level), than if consumers do not spend 100 per cent of their income increase, (which would be the case if the consumption function was stable and had a slope of less than one). Since the demand for goods and services is positively correlated with income, increases in price will follow as a result of increases in income. A similar analysis is appropriate to decreases in income.

Therefore, price variations will be greater if savings balances are stable than if the consumption function is stable. To the extent price variations decrease the efficiency of the firm and household in the allocation of resources over time, the general welfare will be decreased. Thus the simple Keynesian analysis tends to lead persons to overestimate the efficiency of a free price system in the presence of income fluctuations.

Policy Implications. If policy has the objective of promoting the general welfare within a system of free market prices, a test of the success of this policy is the extent to which price changes are made more meaningful guides for the firm and household in the allocation of resources. Thus a dampening of income fluctuations, which decreases the short-period price variation, will permit the firm and household to operate more efficiently. This occurs because they are able to make production and consumption plans for the future on the basis of more exact price expectations and as a consequence promote the general welfare. Stabilizing income of consumers is important for stabilizing the demand for farm commodities, probably more important than previous studies have indicated.

APPENDIX

The rationale of the method used in calculating seasonally adjusted elasticities is as follows: Assume a series of values on income (X) and expenditure (Y) which are connected (exactly) by a constant elasticity relationship of

$$Y = aX^b. \tag{1}$$

Then select any two pairs of values, say (X_1, Y_1) and (X_2, Y_2) and construct the ratios X_1/X_2, Y_1/Y_2. These are related as follows:

$$\frac{Y_1}{Y_2} = \frac{aX_1^b}{aX_2^b} = \left(\frac{X_1}{X_2}\right)^b. \tag{2}$$

Thus the elasticity estimate obtained from the ratios would be identical to the elasticity obtained from the original observations if the elasticity is stable.

The analogue in reference to grocery store sales is that the values are not connected by (1), but values affected by seasonals as well, say $Y(1 + S_y)$, and $X(1 + S_x)$, where S_y and S_x are the seasonals in Y and X respectively. Then, by selecting pairs of values of Y and X for which S_y and S_x are the same and computing ratios, ratios essentially satisfying (2) result. This proof is strictly valid only for constant elasticity curves, but is approximately valid for straight lines at their means. Thus, to the extent that the r's which were obtained from the ratios were higher than the r's which were obtained from the original unadjusted data, the effect of the elimination of one source of variation is indicated.

The rationale of approximating the effect of seasonality on the regressions and the coefficients of correlation calculated from the original unadjusted data is as follows:

Let actual expenditure be (Y) and equal to $E + E'$.
Let actual income be (X) and equal to $I + I'$.
Let values E and I be supposed the seasonally adjusted observations.
Let values E' and I' be supposed the seasonal components.
Let the small letters designate deviations from the means.

Then:

$$r_{YX} = r_{(E+E')(I+I')} = \frac{\Sigma(i+i')(e+e')}{[\Sigma(i+i')^2\Sigma(e+e')^2]^{\frac{1}{2}}}$$

assume i and i′ uncorrelated, and likewise i′ and e, also e and e′.

Then:

$$r_{(E+E')(I+I')} = \frac{r_{IE}\sigma_I\sigma_E + r_{I'E'}\sigma_{I'}\sigma_{E'}}{(\sigma_I^2 + \sigma_{I'})^{\frac{1}{2}}(\sigma_E^2 + \sigma_{E'}^2)^{\frac{1}{2}}}$$

and:

$$b_{(E+E')(I+I')} = \frac{b_{IE}\sigma_I^2 + b_{I'E'}\sigma_{I'}^2}{\sigma_I^2 + \sigma_{I'}^2}.$$

Thus the observed b between the original unadjusted figures is a weighted average of b between seasonally adjusted observations and seasonal components.

The quantitative importance of seasonality in observed income and sales figures was estimated by calculating approximations of:

(1) $\sigma_{I'}^2$, and

(2) $\sigma_{E'}^2$.

From the elasticity calculations the following are known:

(a) $\sigma_{I}^2{}_{+I'} = \sigma_X^2$,

(b) $$\sigma^2{}_{\log}\left(\frac{I_1 \cdot I'_1}{I_2 \cdot I'_2}\right) = \sigma^2{}_{\log}\frac{X_1}{X_2}.$$

Consequently: (b)

$$\log\left(\frac{I_1 \cdot I'_1}{I_2 \cdot I'_2}\right) = \log I_1 + \log I'_1 - \log I_2 - \log I'_2$$

assume $\log I'_1 = \log I'_2$ (which implies that the seasonal is taken to be unaffected by random elements).

Then:

$$(b) = \log I_1 - \log I_2.$$

Then:

$$(b) = \sigma^2{}_{\log I_1 - \log I_2} = \sigma^2{}_{\log I_1} + \sigma^2{}_{\log I_2} - r_{\log I_1 \log I_2} \cdot \sigma_{\log I_1} \sigma_{\log I_2}$$

assume $$r_{\log I_1 \log I_2} = 0.$$

Then:

$$(b) = \sigma^2{}_{\log I_1} + \sigma^2{}_{\log I_2} \quad \text{or if} \quad \sigma^2{}_{\log I_2} = \sigma^2{}_{\log I_1}.$$

Then:

$$(b) = 2\sigma^2{}_{\log I_1}$$

from (a)

$$\sigma^2{}_{\log X} = \text{(approximately)}\ \frac{\sigma_X^2}{\bar{X}^2}.$$

Now

$$\sigma^2{}_{\log X} = \bar{}\sigma^2{}_{\log \bar{}I} + \bar{}_{\cdot}\sigma^2{}_{\log I'}$$

(because assuming seasonal component uncorrelated with non-seasonal component).

Hence

$$\sigma^2{}_{\log I'} = \sigma^2{}_{\log X} - \tfrac{1}{2}(b) = \frac{(a)}{\bar{X}^2} - \tfrac{1}{2}(b).$$

ECONOMIC EFFECTS OF FLEXIBLE LAND CREDIT ARRANGEMENTS

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THE ratio of fixed charges on land debt to the debt-carrying capacity is a strategic one for mortgaged farms. If the level of current income lags behind the requirements for family living and debt service, loss of title is the legal result. When current farm incomes are substantially below the level of current obligations long enough to exhaust reserves, then land purchases decrease, debt payments stop, land debt increases, and a wave of foreclosure takes place. The crest of one wave of foreclosure was seen in the 1930's. The social desirability of action to forestall another such wave has been in the thinking of agricultural leaders ever since. In fact, the main point of concern about the level of land prices and land debt has been and continues to be focused upon the prevention of the distress which arises when deflation follows inflation.

The depression of the 1930's, with its wave of foreclosures, prompted a number of adjustments in the farm credit system. Some of these may be called flexibility provisions, inasmuch as by their use additional flexibility was engendered in the land-credit system. But the measures were designed and put into effect as adjustment programs to deal with exigent situations. Any flexibility added thereby was apparently coincidental to the other and major purposes.[1]

One of the social objectives in improvement of the land credit system is to decrease the number of farm foreclosures. In this respect it must be noted, however, that the device of foreclosure as a legal process is essential to the functioning of an economic system. Undoubtedly during the depression years some cases of lender-borrower relations should preferably have gone through foreclosure rather than through all the steps that were taken to avoid it; the alternative adjustment might have been cheaper to

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* This paper grew out of work done on North Central Regional Publication 19, entitled "Improving Land Credit Arrangements in the Midwest." The purpose is to explore further some of the theory of flexibility in land credit.

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[1] For more detail see: Improving Land Credit Arrangements in the Midwest, North Central Regional Publication 19, June 1950, Purdue University, Agricultural Experiment Station Bulletin 551.

both parties, in the long run. Also, there were undoubtedly many cases that went through foreclosures unnecessarily; if other means had been tried, some foreclosures could have been avoided. No system of operation can be devised to take care of all cases in all circumstances, because of the inaccuracies of prediction in a world of change.

A land credit system with built-in flexibility might well have sets of rules and laws concerning deficiency judgment, moratoria, conciliation, and voluntary adjustment, under particular circumstances. However, if, through time, these went so far as to make the investment of private funds in mortgages unprofitable or unattractive, private funds would not be invested in land loans. The extent of legal protection for borrower and lender are points for policy decisions. Some of these have been made, but they are always subject to change if change will better serve the public interest. As one views the nature of the adjustments that were made in the 1930's, and looks to the future, it is safe to assume that public opinion will favor processes of adjustment without the rigor of social loss that characterized the early 1930's.

Farm mortgage debt promises for the future somewhat greater problems than has been the case during the last 10 years. Numbers of mortgages and debt per farm mortgaged are increasing, without a corresponding increase in debt-carrying capacity. In this environment, further development of flexible land credit arrangements might well be encouraged, to avoid some of the drastic action of emergency adjustment and the pressures that numerous pending foreclosure cases exert.

Use of additional provisions for flexibility in land credit poses important questions. Among them are the following: 1. How would greater flexibility in land credit arrangements affect the supply of loan funds? 2. How would greater flexibility affect the demand for land credit? 3. Would the decrease in uncertainty resulting from use of flexible credit provisions be reflected in land prices?[2] An understanding of the relevant theory and an appreciation of the extent and direction of the departures of the real from the theoretically perfect system may well lead to adaptations in borrowing and lending practices and improvement of the land credit situation. A few of these instances are indicated in the following discussion.[3]

[2] Much the same considerations are needed in the case of operational credit. Although the two are inseparably related in the farm as a firm, the discussion is separate here in order to be more succinct with particular problems. By way of emphasis, however, it must be noted that the gains possible through flexibility in land credit may soon be lost if accompanied by rigidities in operating credit. For a recent discussion of short-term credit see the North Carolina Agricultural Experiment Station Technical Bulletin No. 89, December 1949, entitled "Investment Credit To Improve Farming Systems."

[3] Aside from the point of discussion here, but apropos the application of lessons from theory, it is entirely possible that more attention to explicit comparisons of marginal revenues and marginal costs would affect current investment practices sig-

Flexibility in land credit arrangements may be defined as the adaptability of payment procedures to changes in farm income. The adaptations are confined to the schedule of payments on mortgage debt. The concept of flexibility is limited to the idea of debt payments fitted to the flow of farm income. The fitting process is determined in advance of completion of the contract, by agreement between the borrower and the lender. In short, flexibility is a built-in feature of the contract, governing action of the parties thereto, under given future conditions. It involves a decrease in rigidities in the operation of the credit system. Variable annual payments are the essence of credit flexibility.[4]

For the purpose here, at least two assumptions must be made. First, farm income will continue to fluctuate, but public programs of one kind or another will prevent widespread depression. Under this assumption, farm income may vary from year to year, and from one part of the nation to another. Thus, action on the debt position of some farmers will be necessary even in years in which the national farm income is favorable. The discussion makes no attempt to show how programs which deal with the farm-income problem also make contributions to the debt and credit problems. Second, the land credit system is not expected to perform adjustments in types of farming or to correct maladjustments in land utilization. These problems are not credit problems, although they are closely related. Admittedly, a smoothly functioning land-credit system is essential to stability in land tenure and operation of the system must be fitted to any adjustments that are made in dealing with the farm-income problem and with problems of land-use adjustment.

1. *Flexibility and the Supply of Loan Funds*

In theory, a perfect credit system would supply loan funds in the quantity demanded, at all times. The perfect credit system would be part of a perfect capital market which would equate rates of return in all investments and would equate the expectations of borrowers and lenders. The perfect credit system would be flexible.

Other things remaining the same, the addition of flexibility provisions to mortgage contracts would not disrupt the supply of loan funds. There is no reason to doubt that with a flexible land-credit system in operation,

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nificantly. One hypothesis is that such study would motivate additional loan-financed investments in land. The marginal efficiency of capital invested in land is apparently higher than the current rate of interest, and the marginal value product of land above the annual cost of land.

[4] Discussion of the characteristics of unsound credit, of appraisal procedures, loan values, loan limits, and equity requirements is not relevant to the instance of flexibility in credit arrangements. Supposedly those other features of the contract would also be given proper attention. They are not part of the flexibility provisions, though the results of the use of credit are also dependent on these features.

an adequate supply of land credit would be forthcoming. The funds would be sufficient to meet the demand. When borrowers and lenders had become accustomed to the new arrangements they would act much as before. But at least two shifts would result. First, there would be a shift in source of loan funds, with relatively less supplied by individuals and somewhat more by lending institutions. Second, assuming that the essential legal changes were made to enable the use of fully flexible contracts by the federal credit agencies, those agencies might be expected to handle a larger percentage of the farm-loan business.

The actual amount of shift in loan funds supplied by various lenders as a result of the addition of flexibility provisions would be hard to estimate or measure. Many forces would be operating to affect the shift in one direction. There would be no accurate method of deciding whether the shift were a result of the addition of flexibility provisions or a result of changes in marginal efficiency of capital among possible investment opportunities. Only the direction of change in source of funds can be predicted. This shift among lenders would result from the liquidity preferences and the liquidity positions of lenders and borrowers as they adjusted to changes in the economic environment.

A simple illustration may demonstrate that the proportion of funds supplied by institutional lenders, and especially by federal credit agencies, would increase. Individuals who invest in farm mortgages usually depend upon the annual flow of income from such investment for current living expenses. Widows of farmers, for example, have historically been dependent upon income from the farm rental or from the mortgage that is taken to settle the family estate. In any prolonged period of declining agricultural income during which the flexibility provisions were in effect, such persons would feel the loss of the postponed income rather immediately. In contrast, the large institutional lender with loans spread over many geographical areas is in a stronger capital position than is the individual who holds only one or a few mortgages in one area. If the marginal efficiency of capital in farm land mortgages appeared at least as favorable as that in the other investment opportunities open to institutional lenders, such lenders would take over some of the mortgages held by individuals.

Opportunity for refinancing, and for sale of the mortgage note by the mortgagee, is clearly a necessary part of any workable land-credit system. Otherwise, distressed lenders and borrowers would be too much bound by the system. The liquidity position of individuals as lenders is an important part of the operations of the credit market, since something more than 45 per cent of total outstanding mortgage loans is held by individuals.

If, in a period of low farm income, there were a shift from individuals to institutions for loan funds, it is also reasonable to expect that the shift would be in the other direction in a long period of rising farm income.

This shift back to individuals as a source of funds would be by new mortgages, and possibly because lending institutions would be slower than individuals in adjusting loan levels to the increasing land values that accompany favorable farm incomes.[5]

In any extended period of unfavorable farm income there would be a shift to federal credit agencies as a source of mortgage funds. Such a shift is more probable in high-risk or one-crop areas, because the chances of low income are greater there. In this instance, as above, the shift would take place largely by the transfer of existing mortgage notes to lenders who could afford to hold them. The additional volume of business would also be attributable to cases of refinancing and to new borrowings. With provisions available to handle the refinancing, sales of notes, and new notes, the shift could be accomplished with less distress than in the 1930's.

That the supply of loan funds would be adequate for the operation of the flexible credit system in event of any probable shift of demand can be reckoned by a quick review of the institutional and legal situation in farm mortgage credit. Under a fully flexible system the federal agencies could write truly flexible contracts, since, by assumption, present legislative and administrative barriers in this respect would be removed. The only further assumption needed is that the public at large would be willing to buy the bonds which provide the loan funds for the lending agency. Judging by past experience, if other sources of loan funds were temporarily lacking, funds would be made available to the lending agencies by direct appropriation.

The legal and institutional environment of the land credit market in this sense changes the shape and the slope of the supply curve for mortgage funds. In the competitive market in which no firm dominated, the supply curve for loan funds would be the orthodox upward-sloping one. In the loan funds market dominated by the activity of one agency or set of agencies, the supply curve would be a straight horizontal line, within the relevant area and a series of horizontal lines giving a modulated stair-step effect above and below this relevant area. The prevailing rate of interest, say 4 per cent, would be the main landing on this stair. At this rate lenders would be willing to exchange their dollars for mortgages. A half-per cent rise in the interest rate, resulting from a similar rise in interest on bonds, would shift the horizontal line upward. The curve is discontinuous, for interest changes mainly on half-per cents.

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[5] Data on loans held by principal lender groups bears out this hypothesis. In 1935 roughly 38 per cent of the debt was held by individuals. This decreased to 33 per cent in 1940, by which time the bulk of farm foreclosures had been made and lending agencies were beginning to sell real estate. After 1940 the percentage of total mortgages held by individuals increased, until in 1950 they held over 40 per cent. In 1951, individuals and others held the largest volume of loans of any lending group. For detail data, see *Agricultural Finance Review*, Vol. 13, Supplement, May 1951.

What is the effect of flexibility provisions *alone* on the elasticity of supply of loan funds? Again the case is one of several forces working in the same direction. Federal facility for land credit tends to make the supply schedule horizontal, whether or not there are flexibility provisions available. But the ability of an agency to offer flexibility and thereby bring this service into use has the effect of extending the horizontal line to the right.

This does not mean that the supply schedule is horizontal indefinitely. An unlimited amount of funds would not be supplied at any one interest rate. Rather, the horizontal curve, rising by steps, means that funds would be forthcoming at several interest rates, to meet any conceivable demand. Quantity at any one interest rate is conditioned by the collateral that borrowers have to offer.[6]

One disadvantage of a flexible contract over a straight amortization schedule for a lender is that his liquidity position may not enable him to meet the terms of the flexible schedule. He may need the income from interest and principal at the same time that the borrower needs the postponement in payment. The increase of foreclosures and the tremendous demand on the Farm Credit Administration in the early 1930's arose largely from lenders in liquidity positions which to them were untenable. Refinancing, or sale of the contract could provide opportunity for lenders who cannot afford postponement of current income.

Another disadvantage of the flexible contract is that for the multiple mortgage lender the costs of supervision are higher. More records are needed to keep current on variable payments and to calculate the annual payments on a sliding schedule or changing base. The solution is an increase in the interest rate, to cover the added cost. If borrowers are willing to pay for this added service, then the flexible payment provisions would have no effect on the supply of funds. But if lenders are expected to supply the additional service without recompense, there would be a decrease in funds available.

The general availability of loan funds with a flexible credit system in operation depends mainly upon public policy. Public opinion can and

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[6] Other facets of the elasticity of supply of loan funds appear to warrant careful theoretical analysis, but not as part of an examination of the effects of flexibility provisions. Among these: What are the effect of differences in purpose for which funds are sought by borrowers? Are lenders equally willing to supply funds, regardless of the purpose for which funds are sought, taking into account only the question of the safety of the loan for the farm as a whole? And, what is the difference in elasticity of supply in inflation as compared to deflation? Further analysis of the extent of competition might also be enlightening. In the present loan funds market, competition appears to be in extent of services offered, rather than in interest rate. This has the effect of making mortgage contracts a differentiated product. The situation is one of monopolistic competition, regardless of the horizontal supply curve in the relevant area.

does change, but unless there are substantial changes in the basic policy and legislation under which the federal credit agencies operate, a generally adequate supply of funds for farm loans is likely to be available. Mainly, this means that there will be a greater supply of funds during depression and recession, in the future.

This does not mean that any one individual will be able to borrow all the money he wants, even if he has collateral. A sufficient aggregate supply does not automatically guarantee a supply for an individual borrower. But, an individual's chances for obtaining necessary loan funds would be greater in the long run if they became greater in the short-run of depression years.

The range of the horizontal supply curve extends far enough to take care of total needs of borrowers—needs being defined in terms of economic feasibility and ability to repay, and not in terms of wants. The addition of flexibility provisions to the credit system essentially extends the range of supply curve further. Lenders see that borrowers are enabled to bridge the low-income years and lenders are more willing to supply funds in such cases than to take a chance on being forced to go through the foreclosure procedure to collect. This is also a phase of the demand side of the picture.

2. *Flexibility and the Demand for Loan Funds*

Additional flexibility in the operation of the land credit system would increase the demand for loan funds. The increased demand would come about mainly through changes in the significance of the relation between annual income and the annual debt-carrying capacity of the farms. Under a rigid schedule of payments, one year of inability to meet payments can result in loss of title. Under a variable payment plan, with extension of interest and principal, several years of adverse income may be weathered. The chance of loss of title by the mortgagor is decreased.[7]

The problems of prediction for periods of 30 or 40 years are the same, whether the credit system as a whole is flexible or inflexible in operation. Individuals would be required to make the same kinds of estimates of future incomes, costs, and probable returns. Whether knowingly or not, each prospective borrower on or buyer of land makes an estimate of these future events, when he commits himself for the purchase of a farm. As a buyer he is estimating the flow of net land income, assuming a discount rate, and expressing his estimate in a fund of value. The seller makes the same kind of estimates for his decisions. Technically these estimates are the same, regardless of the flexibility of the payment schedule which may be used on the mortgage that finances the purchase. The estimates of annual income are unaffected by the terms of payment. The significance

[7] Three illustrations of variable payment plans are given in North Central Regional Publication No. 19, cited earlier. The reader is referred to this for more detail.

of variations in flow of income is another matter. The effect of income variation is reduced when the payment schedule is fitted to income.

The presence or lack of flexibility in the operation of the payment schedule can affect the decision of the land buyer and the borrower. Even though the estimates of the flow of farm income are the same, the nature of the risk and uncertainty involved is not the same with flexibility provisions as without. If uncertainty is thus decreased, more persons will be willing to buy land and additional persons will be willing to mortgage land. How much or how many more is conjectural.

The significance of decrease in uncertainty through use of flexibility provisions may be further illustrated with an income projection. Suppose the individual formulates his expectations by projecting his past incomes into the future. He need not assume the same sequence. All he does is to assume that net farm income of the future will be distributed between the low and the high that he has experienced, in the same frequency as in the past.

With a projection of the past 15 years or so of net farm income per farm, most cases would thus give an expectation of loss of title with a probability of something less than 1, under a system of fixed annual payment plan. If the individual projection contains several years of minus income in sequence, the probability of loss would be certain—with probability 1. Taking account of necessary expenditure for family living increases, the number of years in which no payments can be made on a mortgage thus increases probability of loss. The fixed payment plan gives rise to uncertainty.

If the mortgage becomes effective at the beginning of a series of low and minus income years, even under the flexible payment plan, debt approaches appraised value. In such instance, if the distress is widespread, special relief programs may be the choice to minimize social loss. A detailed discussion of the characteristics of the flexible credit system would include explanation of the types of provisions that are needed to deal with those cases which become over-involved by continued low income. It is obvious that the lender must be protected against loss, and the borrower against a hopeless future. Supposedly there would be varying arrangements, differing among farming areas and type of farming, to account for the differences in risk. But within the given area there still might be instances of succeeding drought or grasshopper years, beyond historical experience, which neither borrower nor lender can afford. This problem is general for all credit, rather than unique for flexible plans.

With a system of flexible payments, the probability of loss of title approaches zero. The burden of the annual payments on the mortgage is shifted from the low to the high-income years. Although the income from the given year remains unknown, the individual operates with certainty

that mortgage payments can be made in the longer run. The average income over a period of years, rather than that for the single year, becomes the measure of debt paying capacity.

In effect, a flexible payment plan tied to net farm income changes the borrower's interpretation of the future. Supposedly this same advantage is obtainable at the choice of lender and borrower, by agreement, without the formality of a flexible contract. But experience has shown no particular propensity of borrowers to make use of such privileges, nor of lenders to grant them. The many advance payments on mortgages from 1940 to date was largely because borrowers had the cash to make payments and demanded the privilege. Technically, many of these mortgages on which

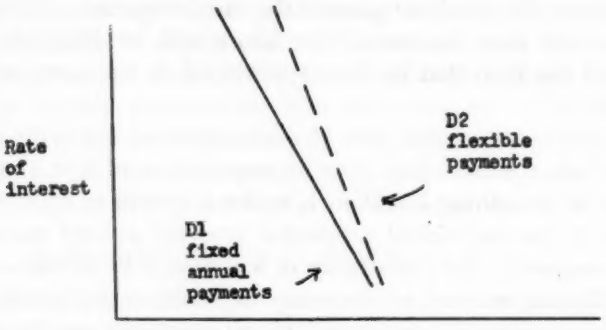

FIGURE 1. DEMAND FOR LOAN FUNDS UNDER FIXED AND FLEXIBLE PROVISIONS FOR REPAYMENT[a]

advance payments have been made can become delinquent, by the missing of one current payment.

In theory, the appraised value of a farm is the same whether the payment is flexible or rigid. Income-earning ability is not affected by the repayment plan. But the debt-carrying ability or capacity is affected by the repayment plan. The total effect is to increase the demand for funds. The aggregate demand under the two systems is hypothesized in Figure 1.

With flexibility provisions adopted generally, the demand for loan funds increases. The schedule changes slope and shifts up and to the right. Persons who were willing to borrow at 6 per cent are willing to

[a] This illustrates only the effect of a change in payment schedules upon the demand for loan funds. D1 is assumed as the demand under a system of fixed annual payments. The marginal efficiency of capital invested in land (titles and mortgages) and interest rates are known; technology, tastes, prices, and income remain unchanged. D2 is the demand schedule after variable payment plans become available.

increase their borrowings relatively more than are those who were willing to borrow at 4 per cent. In other words, decreasing the uncertainty would have greater effect on the demand for funds at 6 than at 2 per cent. The range in the diagram is purposely limited, because of the inconsequence of loans at above 7 and below 2 per cent.

It is reasonable to assume that numerous borrowers would be willing to take the same risk as before the change. Therefore, many borrowers would take more funds after the change. Since the flexibility provisions decrease risk more for the six percenters than for lower ones, the six percenters would take relatively more funds at the same interest rate. Also, with the decrease in risk and uncertainty, some individuals would become willing borrowers at a higher interest rate. This too would shift the demand curve.[9]

If there were any voluntary self-rationing by individuals, because of fear of loss, a change in flexibility would cut down such rationing. More individuals would be willing to ask for the limit of loan available. In general, demand for loans would increase.

3. *Flexibility and Land Prices*

Under the assumptions that flexibility in land credit includes no provisions other than for flexibility in payments, there is no basic justification for a general increase in prices of land. Availability of credit, the pressure of funds seeking investment, a general belief that inflation is inevitable, and like forces or relations all promote inflation in land. These are aspects of the general problems of inflation which are largely unaffected by additional flexibility provisions as defined here. These and other factors and forces will have far greater impact on the level of land prices than will flexibility provisions, and in fact because of them or of other combinations, it may be impossible to isolate the influence of the added flexibility provisions, in practice. But, assuming that these larger forces are held constant, what is the effect of added flexibility provisions on land prices?

Additional flexibility in the operation of the land credit system will tend to encourage higher offering prices by some buyers and may encourage more bids, even though such provisions have no effect on the incomes that determine the income-producing value of farm land. Flexibility pro-

[9] For evidence on the significance of uncertainty as related to borrowing to expand farming operations, see Earl O. Heady and Earl R. Swanson, "Resource Productivity in Iowa Farming" Agricultural Experiment Station, Iowa State College, Research Bulletin 388, June 1952. Of farmers interviewed, 25 per cent gave price uncertainty as a reason for not borrowing; 79 per cent said they would not borrow more even if no interest were charged. p. 773. The difference of 3 or 4 per cent in the interest rate evidently is less important than uncertainty and other considerations which limit use of borrowed capital. p. 772.

visions help bridge the low-income years and add to the certainty of retaining title. In this sense they add to the certainty of income. The certainty of income is in terms of being allowed or able to receive it over a longer period of years, rather than in terms of assuring an income for any given year.

As an illustration, take the case of land prices in an area in which a number of years of crop failure are a normal expectation. Supposedly, through experience, both buyers and sellers have learned to discount properly the effect of these years of low income. The uncertainty of income, its range, and its average, among other forces, help to determine the estimates of buyers and sellers as to how much they can afford to pay or to take for their land. When certainty of loss of title decreases through the addition of flexibility provisions in credit, some persons will bid more in order to obtain title to the land.

The extent of rise in land prices would be limited in amount. Sound appraisals would set the appraised value of the property—at least for public agency loans and for loans by institutional lenders. In general, appraised values have been conservative. It would be the individual lenders, particularly purchase-money mortgages, that would exert the influence. Individual buyers might bid far beyond the income-earning value of the property—even as does the occasional buyer who operates under the present system, without flexibility. But it is doubtful whether change in flexibility alone would significantly change the sets of offering prices by buyers—unless the decrease in risk resulted in a general lowering of the capitalization rate. A "safe" investment is often more attractive than is lesser certainty of great gain.

Flexibility in the land-credit system would have more appeal to landowners in high-risk areas than to those in areas of moderate climatic hazard. The chance for a year of crop failure is definitely greater in the western Great Plains than in the center of the Corn Belt, because of the differences in rainfall alone. Seemingly then, more persons in the higher-risk areas would be seeking risk-spreading devices, to span the low-income years.[10] Geographically one would expect differences in the additional demand for credit and also in any change in land prices that would be attributable to flexibility of land credit.

Conclusion

As additional flexibility provisions are developed and applied, many adaptations will be needed from area to area. It is not expected that a flat percentage of net income as the base for annual debt payment would

[10] For pertinent discussion of risk-spreading devices for the Great Plains see *This Journal*, Proceedings November 1949, pp. 931-954, and the symposium in the August 1950 issue.

work the same in dry-land production of wheat as in corn-hog farming. Also, it is obvious that gains made through the adoption of flexibility provisions could easily be outweighed by other developments. Particularly, those in land credit must be supplemented and complemented by like ones in production credit.

The hypotheses discussed here are only some of the more important questions in the theory framework within which credit programs operate. How can annual payments on debt be fitted to the flow of income, simply, effectively, and inexpensively? More important, will borrowers and lenders be interested enough in probable effects to develop and adopt the provisions in a period of favorable farm income? Students have noted that in times of crises, adjustments are usually more drastic, because of the pressures exerted. The effects depend upon the content, and the content often results from the "times."

NOTES

A BRIEF NOTE ON SCHOOLS OF THOUGHT

RETROGRESSION in scientific analysis occurs when allegiance is pledged to men rather than to impersonal procedures. Such an occurrence may be developing among some agricultural economists and is suggested by recent articles in *This Journal.*[1] Allegiance to men (or schools) rather than to impersonal procedures suggests a likelihood of the acceptance or rejection of a set of relationships and values, or of questions to ask, without a critical examination of the alternatives.

Understandably, writers will at times find it a convenient shorthand to identify certain rationales with individuals. However, the cost of this shorthand may be high. This simplification tends to lead students to rely on "authority" rather than "reason." Those relying on "authority" find more importance in learning what the "good book" says than in learning how the world works. The personification of ideas seems to be, in general, associated with the generators of much heat and little light (e.g. the arguments between Marxians and others, Keynesians and others, institutionalists and others). Little net gain is to be realized by writing articles in a way that tends to divide agricultural economists into opposing schools. If such sport is found to be irresistible there are other fields where the damage already has been done that provide a relatively harmless outlet for such an urge.

Advance in agricultural economics, as in all science, will occur more rapidly when hypotheses are tested because of their content rather than because of their pedigree. This permits and facilitates the cumulation of knowledge.

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[1] For the most recent example of an article that suggests this trend see William O. Jones, "The New Agricultural Economics," *This Journal*, Vol. XXXIV, No. 4, Nov. 1952, Pages 441-450.

PRODUCTION FUNCTIONS DERIVED FROM FARM RECORDS—A CORRECTION*

PROFESSOR W. O. JONES of the Food Research Institute, Stanford University, has kindly pointed out some computational errors which occurred in the article "Production Functions Derived from Farm Records," published in *This Journal*, August 1944, pp. 566 ff.

Table 3 on p. 569 should read as follows:

TABLE 3. ESTIMATED MARGINAL PRODUCTIVITIES (PER DOLLAR OF INPUTS) AND FIDUCIAL LIMITS (AT FIVE PER CENT LEVEL)

	Land A	*Labor* B	*Improvements* C	*Liquid Assets* D	*Working Assets* E	*Cash Operating Expenses* E
Total						
Mean	0.0981	1.0519	0.0449	0.1790	0.1585	0.2808
Upper Limit	0.1188	1.4825	0.0923	0.2433	0.2898	0.3941
Lower Limit	0.0775	0.6213	–0.0025	0.1157	0.0272	0.1675
Hogs						
Mean	0.1277	1.9555	0.0778	0.5446	0.2445	0.7022
Upper Limit	0.1869	3.2231	0.2106	0.7611	0.5863	1.0252
Lower Limit	0.0685	0.6880	–0.0550	0.3282	–0.0974	0.3792
Beef Feeders						
Mean	0.1205	1.4837	0.0814	0.1964	–0.1171	0.0824
Upper Limit	0.1610	2.4297	0.1894	0.2945	0.2097	0.2749
Lower Limit	0.0800	0.5378	–0.0266	0.0984	—0.4441	—0.1101
Dairy						
Mean	0.0836	0.0361	0.0085	0.3258	0.1641	0.9018
Upper Limit	0.1635	0.1488	0.2141	0.6855	0.5586	1.5800
Lower Limit	0.0037	–0.0766	–0.1971	–0.0339	–0.2304	0.2236
Crops						
Mean	0.1381	1.9006	0.0766	–0.1419	0.1902	0.4404
Upper Limit	0.2022	3.0896	0.2148	0.0947	0.5703	0.8671
Lower Limit	0.0740	0.7115	–0.0616	–0.3785	–0.1899	0.0136
General						
Mean	0.1322	–0.8827	0.0098	0.3662	0.2989	0.5783
Upper Limit	0.2216	1.5396	0.2100	0.6414	0.8501	1.0928
Lower Limit	0.0428	–3.3050	–0.1903	0.0910	–0.2523	0.0638

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* Correction of Journal Paper No. J-1227 of the Iowa Agricultural Experiment Station.

THE PRICE ELASTICITY OF DEMAND FOR FLUID SKIM MILK*

AVERAGE daily sales of bottled fluid skim milk in city markets of the United States increased by more than 300 per cent from 1947 to 1951, and at the present time sales of this product amount to almost 3 per cent of total fluid milk sales. Skim milk, as a retail product for home use, is relatively new and very little is known of the characteristics of demand for this product. This article reports the findings of two studies directed towards the determination of the relationship between retail price and sales of fluid skim milk, the relationship between sales of fluid skim milk and fluid whole milk and the effects of other factors influencing the sale of fluid skim milk. These studies are important not only for their results but also for the methods followed in estimating the parameters of demand for skim milk. Three methods were employed: one based on an analysis of price-sales observations at a given time, another employing price-sales observations through time, and finally, an analysis of sales and price data obtained from a controlled experiment. In each case the price elasticity of demand for fluid skim was found to be above unity, and the presence of substitution between skim and whole milk was suggested.

Method 1.—Market Price-Sales Relationships at a Given Time

Retail sales of both fluid skim milk and whole milk were obtained for 34 federal order markets of the United States from the respective milk market administrators for the five years 1947-1951, or for as many years as these data were available. Estimates of the prices of both skim and whole milk were based on questionnaires completed by individual milk dealers within the various market areas. This latter operation was facilitated by similar pricing of milk products by dealers within any given market.

The ratio of sales of skim to sales of whole milk was used as a measure of skim milk consumption which would be comparable among markets.[1]

* This paper has been adapted from two Master's theses developed in the Department of Agricultural Economics at the University of Connecticut: Charles H. Berry, *Price Elasticities of Demand for Fluid Skim Milk*, 1953—Donald J. Baker, *Estimates of Skim Milk Demand Derived from Controlled Experimentation*, 1953.

[1] Because of the inability to define the various milk market areas it was impossible to obtain population estimates to adjust skim milk sales data for population differences. The ratio of skim sales to sales of whole milk was found to be the best available adjustment for population differences. Additionally, adjustment is made for seasonality to the extent that the seasonal factors are the same in whole and skim milk consumption. The consumption ratio would overestimate changes in the consumption of skim milk if these changes are associated with an opposite change in the consumption of fluid whole milk. However, at current levels of fluid skim milk price and consumption this bias is small and can be shown to amount to an error of less than 5 percent.

The retail price of skim milk in each market was adjusted for differences in the price of fluid whole milk, and in this case a measure of the ratio of skim milk price to whole milk price was also chosen.

Price-consumption observations of this type were determined for these market areas for the months of April 1947, April 1949, December 1950, February 1951, and April 1951. A measure of the association between consumption or sales and price of fluid skim milk for each period was obtained by correlating market price and consumption ratio observations of each month. Simple linear regressions were fitted employing the ratio of skim to whole milk sales as the dependent variable and the ratio of prices as the independent variable.

The coefficients obtained from these regressions show the change in the ratio of skim to whole milk sales which was associated with a unit change in the price ratio of skim to whole milk during selected time periods. A measure of the percentage change in the ratio of sales associated with a unit percentage change in the ratio of prices for each time period may be found by computing

$$\frac{\Delta\left(\frac{Qs}{Qw}\right)\Big/\left(\frac{Qs}{Qw}\right)}{\Delta\left(\frac{Ps}{Pw}\right)\Big/\left(\frac{Ps}{Pw}\right)} \text{ or } b \cdot \frac{\left(\frac{Ps}{Pw}\right)}{\left(\frac{Qs}{Qw}\right)}$$

Although this measure does not relate consumption and price in the usual way, we feel that in this case it may be used to approximate price elasticity of demand for skim milk.[2] Table I presents elasticities calculated

TABLE I. ELASTICITIES BASED ON SALES-PRICE REGRESSION COEFFICIENTS

Date of Regression Observations	Point Estimate e	95% Confidence Interval of e[a]	
		Lower Limit	Upper Limit
April, 1947	−4.4	−2.0	−15.7
April, 1949	−3.4	−1.9	− 4.9
December, 1950	−3.6	−2.2	− 5.0
December, 1951	−4.0	−2.6	− 5.3
April, 1951	−4.0	−2.4	− 5.6

[a] These interval estimates are derived directly from 95 per cent confidence intervals of the appropriate regression coefficients.

[2] This measure estimates the price elasticity of substitution between skim and whole milk. However, skim milk sales are at present a very small percentage of total retail milk sales, less than 3 per cent in those markets studied. A 10 per cent change in skim milk sales amounts to less than a .3 per cent change in total milk sales at this level. For this reason this elasticity of substitution may be used to estimate the price elacticity of demand for skim milk with very little error. See above, footnote 1.

A discussion of this method of substitution elasticity estimation is presented in James M. Morgan, "Consumer Substitution Between Butter and Margarine," *Econometrica*, Vol. 19, pp. 18-39, 1951.

from regression coefficients and mean values of the appropriate price and sales ratio observations.

Method 2.—Market Price-Sales Relationships Through Time

The following model was tested empirically using yearly data for nine market areas for the full 5-year period 1947-1951:

$$X_1 = a + b_{12}X_2 + b_{13}X_3 + b_{14}X_4 + E$$

where X_1 is the ratio of skim milk sales to whole milk sales, X_2 is the price of skim milk, X_3 is the price of whole milk, X_4 is time in years (origin, 1946), a is the X_1 intercept, and E the residual error.

The following coefficients were obtained:

$$X_1 = .197 - .211X_2 + .135X_3 + .244X_4$$
$$R\ .671$$

This model provides a measure of the average response of the consumption ratio to skim and whole milk price changes as well as to time. The price elasticity relating the consumption ratio to the price of skim milk at the mean values of the respective variables is -3.5, while the cross-price elasticity relating the consumption ratio to the price of whole milk is 3.0. This suggests that the two milk products are substitutes, but does not provide a measure of the extent of this substitution.

Method 3.—A Controlled Experiment

The preceding analyses are limited by an assumption of similarity of consumer preference schedules among market areas. Markets included in the analyses do differ in many respects, and although the effect of this variation may not invalidate this method of demand approximation for this particular product, some error must be attributed to these differences.

This difficulty may be overcome by the use of time series data for a particular or localized consumer population. However, appropriate observations are difficult to obtain, particularly within a time period sufficiently short to ensure that consumer preferences have not changed during the observation period. A controlled market experiment would provide an opportunity to obtain data of this type and would also permit the control of all variables other than the particular variable whose effect the researcher would like to isolate.

Such an experiment has been set up at this station to determine the effects of changes in the relationship between the price of skim milk and the price of whole milk on skim milk sales. This experiment is localized to one community with the participants in the experiment being the consumers of milk supplied by the University of Connecticut Dairy. The experiment itself is of the Latin square design, and consists of a

random assignment of skim milk to whole milk price differentials over a four-year period with each yearly period itself being divided into four bi-monthly subperiods.[3] (The experiment thus runs from October through May of each year with a price preperiod in September.) The exact price patern is given by the complete experimental design which follows:

	Year I	Year II	Year III	Year IV
Preperiod	(A)	(B)	(D)	(C)
Subperiod				
1	A_a	B_b	D_d	C_c
2	B_a	D_b	C_d	A_c
3	C_b	A_d	B_c	D_a
4	D_c	C_a	A_b	B_d

The capital letters having the following significance:

A = 6¢ differential
B = 2¢ differential
C = 4¢ differential
D = 8¢ differential

The subscript letters signify any carryover effect that may exist from a preceding price differential.[4]

With the price and sales data resulting from this experiment, a complete variance analysis of the effects of skim milk price on skim milk sales will be possible in addition to the estimation of various price elasticities. At this time, however, only one year of the experiment has been completed, thus limiting the present statistical analysis.

Using this first year's data in the same ratio form as was used with the data of the 34 city market areas gave an elasticity estimate of -1.68 ± 1.63.[5] Although this price elasticity estimate is lower than those obtained from the two preceding analyses, this may be due in part to the presence of purchasing lags. The price and sales observations for only the first months of the bimonthly price periods, when used in the

[3] This randomization is restricted, however, since each price differential must occur once and only once in each yearly period and in each bi-monthly subperiod.

[4] With the completion of the entire experiment, each price differential will have had all the subscript letters combined with it and should thus be free of any carryover effects.

[5] This elasticity value is somewhat lower than those calculated from the data of the 34 cities. The price ratio is approximately the same in both cases and the *b* value for the Latin square data (which is significant at the 95 per cent confidence level) falls within limits of the *b* values of the 34 cities. Since the same formula

$$e = b\frac{\overline{X}}{\overline{Y}}$$

was used, this lower elasticity value must be the result of a greater mean skim milk purchase for the Latin square data than for the data of the 34 cities.

sales-price regression analysis, resulted in a price elasticity estimate of − 0.87, while the data for the second months of these price periods produced an estimate of − 2.41.[6] This latter value is more nearly what would be expected on the basis of the market area studies.

Some indication of the substitution between skim milk and whole milk was also obtained in connection with this experiment. This was possible since, during the period of October 1950 through May 1951, skim milk was sold by the University Dairy in only very small amounts to those persons who, for some special reason, required a non-fat diet. With the beginning of the controlled experiment in October 1951, however, skim milk became available to consumers in any desired quantity. If it could be shown that there was no significant difference in the sales of skim milk and whole milk taken together between the two years but that whole milk sales were significantly different between the years, substitution between the two milk products would be suggested.

These differences were tested by a student's t analysis. The t value resulting from the test of the difference in average monthly purchases of whole milk plus skim milk between the two years was not significant at even the 50 per cent confidence level, while the t value obtained from the test of the difference in average monthly purchases of whole milk between the two periods was significant at approximately the 90 per cent level of confidence. These tests would suggest that skim milk is at least a partial substitute for whole milk.

Consumer incomes were obtained from a sample of the customers of the University Dairy so that the possible effects of income on skim milk purchases could be investigated.[7] Both skim milk expenditures per household and total yearly income per household, and skim milk expenditures per household and average yearly income per household member were correlated. In neither case was the association found to be significant at a commonly accepted level of confidence. Thus little evidence was found to indicate that income significantly affects skim milk purchases.

The consumers interviewed were also asked to predict their purchases of fluid skim milk at varying skim milk to whole milk price differentials. Predicted purchases were compared with actual purchases recorded at these same price differentials for these same persons during the first year of the controlled experiment, once again by the student's t analysis.

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[6] Although an F. ratio test showed that the two b values from which these two elasticities resulted were not significantly different at the 95 per cent confidence level (with only the four monthly observations), a comparison of the two elasticities does provide a hint that some purchase lags did occur after the price changes.

[7] These income figures were checked for accuracy by calculating correlation and regression coefficients using reported gross yearly university income, as taken from the survey forms, as the dependent variable and actual gross yearly university income, as taken from public records, as the independent variable. The resulting r was 0.92 while the b was +0.88.

The difference between predicted purchases and actual purchases (the predicted purchases, on the average, being greater than actual purchases) was significant at the 99 per cent confidence level.[8] This difference could have resulted in part from an insufficient consumer knowledge of price, since 70 per cent of those purchasing skim milk at the time of the survey did not know the exact price of skim milk even though they were notified of each price change during the experimental period. This analysis might also suggest that the length of the two month price periods is not sufficient to allow for an elimination of the various purchasing lags which may follow the experimental price changes. At any rate, this analysis does not support the use of consumer estimates of purchases at varying prices as a valid means of demand determination.

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CONSOLIDATION OF THE DAIRY INDUSTRY IN WISCONSIN*

IN 1922 Wisconsin had about 4,000 plants in the categories of creameries, cheese factories, receiving stations, condenseries and drying plants. These plants received a total of about 8½ billion pounds of milk from farms. Hence average milk receipts per plant were slightly more than two million pounds for the year.

Thirty years later, in 1952, there were only about 1,500 plants in the state performing comparable functions, but together they received about 13¾ billion pounds of milk during the year. Thus average receipts per plant were about 9 million pounds, more than a fourfold increase over 1922.[1] In this note we shall take a brief look at the story behind this consolidation.

At one time the Wisconsin dairy industry was mostly a butter and cheese industry, composed of a large number of plants that were small by modern standards. The industry was well established before trucks were in common use, and when hauling from farm to plant was done

[8] Predicted purchases and actual purchases were also compared at each individual price differential. The predicted purchases were significantly greater at both the 6 and the 8 cent price differential, while at the 2 and the 4 cent differentials no significant difference was found. The comparison for the 2 cent differential differed, however, from the comparisons for the other differentials in that, at the 2 cent differential, the mean predicted purchase was less than the mean actual purchase.

* Data presented in this report represent or were derived from original data collected by the Federal-State Crop Reporting Service for Wisconsin. The writer is indebted to his colleagues H. L. Cook and A. H. Miller for assistance in the analysis.

[1] All milk statistics are in terms of milk equivalent which converts other dairy products, such as cream, into milk units. Because about half the milk equivalent was received by plants in the form of cream in 1922, whereas almost all of the receipts at present are in the form of whole milk, a comparison of milk equivalents understates the increase in quantity of product handled per plant over this period.

by team and wagon it probably was a rare occurrence where cream or milk was hauled more than five miles. The size of a dairy plant was limited by the small territory from which it could secure milk.

With the advent of better roads and the common usage of route trucks, the supply territory of a dairy plant was expanded greatly. Also, milk production on farms increased. With more milk available to a plant, operations could begin early and continue throughout the day. This increased utilization of the plant reduced the processing cost per unit of output.

As time went on, the trend toward larger scale operations was accentuated by the invention and use of labor saving machinery such as can

TABLE I. BASIC DAIRY PLANT OPERATIONS LICENSED BY THE STATE OF WISCONSIN, 1922, 1952

Type of operations	Number of licenses granted[a]	
	1922	1952
Butter manufacture	667	266
Cheese manufacture	2,807	1,173
Receiving and reshipping	675	308
Condensing	67	89
Drying	—	118
Totals	4,216	1,954

[a] The number of licenses exceeds the number of plants because, especially in recent years, individual plants have been equipped to perform several of these operations.

washers, conveyors, and improved processing equipment. Such equipment increased the amount of milk a plant could handle, and also decreased the labor cost per unit of output.

Improved transportation facilities enabled the plants to compete more vigorously for the milk supply. In the long run, the most efficient plants could bid the milk away from the less efficient. The latter could not pay the competitive price for milk while still maintaining adequate depreciation reserves and adequate returns to owners and managers. Gradually these plants went out of business, their milk being diverted to the more efficient processors. As this went on, new plants were being built; but they tended to be the larger ones of their type, and their numbers did not keep pace with the old plants that were being retired.

In this way economies of scale took their effect, but, in addition, the basic structure of the industry underwent a change. This is indicated in Table I by a comparison of the number of state licenses granted for the basic types of dairy plant operations. The table shows that whereas butter, cheese and receiving operations declined sharply in number in the past 30 years, the condensing operations increased, and drying operations made all of their growth.

A milk evaporating operation requires expensive equipment which must have a large volume of output to operate efficiently and to carry the overhead cost. Milk may be dried on a relatively inexpensive roller drier, but much of this powder sells at a discount below the price of powder produced by the spray process. On the other hand, spray drying equipment generally is more expensive than roller equipment, and a spray drying unit requires much more milk for its efficient operation.[2] For these reasons the condensing and spray operations tended to be the largest of the basic types shown in Table I.

Table II conveys an idea of the relative sizes of some of the basic operations and their change, over time. The cheese operation is the smallest, but it has shown a high and steady rate of growth in size. The butter operation is somewhat larger, but has shown neither a high nor a consistent growth rate. The condensing operation is by far the largest of the three, but shows no consistent trend in size.

Relating the data in Tables I and II, it is easy to see how the increase in the number of large-volume types of operations (such as condensing)

TABLE II. AVERAGE UTILIZATION OF MILK PER LICENSED OPERATION, FOR THREE TYPES OF OPERATIONS, 1929, 1938, AND 1948–49

Type of operation	Amount of milk utilized per licensed operation		
	1929	1938	1948–49[a]
	Thousand pounds	Thousand pounds	Thousand pounds
Cheese manufacture	1,413	2,029	4,295
Butter manufacture	6,006	7,498	7,162
Condensing	17,552	19,737	16,440

[a] In 1948 the aggregate utilization of milk in creamery butter was unusually small, but it was unusually large in 1949. On the other hand the reverse was true of condensery products. To give a more representative picture, the average of the two years is used.

and the decrease in the number of small volume types (such as cheese manufacture), plus the average increase in size of the latter, all together would exert a strong influence tending to raise the average intake of milk per plant. But this would not yet account for the present average milk intake of nine million pounds for the plants performing the operations listed in Table I.

The answer lies in the growth in size and number of multiple-operation plants. At present, there are individual plants equipped to perform all of the types of operations shown in Table I, and some of these plants

[2] Recently a small-scale spray drier has been introduced, and seems to be performing suitably, though perhaps not completely matching the efficiency of the large units.

receive more than 100 million pounds of milk during a year. What accounts for this trend?

Economies in both marketing and production seem to have led to the growing importance of these plants. Because of dynamic elements operating in the economy, there are continual shifts in the relative profitability of producing different types of dairy products. These differentials in profit margins often exceeded the cost of shifting production from one product to another, so firms sought flexibility that would enable them to take advantage of changes in relative prices. Originally this led to the formation of multi-plant firms with the different plants specialized to produce different end products. But because each plant had its particular farm supply of milk it was necessary to shift supplies of this raw material as production emphasis was shifted from one plant to another. Thus a transportation cost problem was posed.

Almost all of the commercial milk in Wisconsin is collected on so-called "can routes." A route consists of a designated group of farms in a certain area, selling milk to a certain plant. Every day a truck makes the rounds of the patrons, collects the 10-gallon cans which are filled and waiting at the farms, and delivers them to the plant.[3] Most plants are supplied by a number of such routes, the number depending on the size of the plant.

It was not economical to send these route trucks, with their small payloads, over the sometimes considerable distances to the other plants in a multi-plant organization. So the plants continued to receive milk from their own routes, but they also were licensed as receiving stations. When it was necessary to ship milk between plants, large payloads were carried in rail cars or, later, in tank trucks. This system enabled firms to seize not only marketing economies resulting from product flexibility[4] but also production economies resulting from the concentration of large amounts of milk at the plants at which production was being emphasized.[5]

However, there were faults in these specialized plant systems. The full utilization of by-products required firms either to install additional processing operations at the specialized plants, or else perform a large amount of back-hauling. For example, a butter factory would receive milk, separate the cream and make butter from it, leaving the skim milk by-product. Rather than haul it to another plant it would be desirable to dry

[3] Recently bulk pick-up, eliminating the cans, has been introduced in Wisconsin, but it is, as yet, on a very small scale.

[4] If only one product is being considered, then marketing economies are associated with long-term sales contracts and steady rates of production. But if a number of products can be made from the same type of raw material, then marketing economies must be considered in relation to the complex of possible end products. If the relative prices and profit margins of these products are subject to substantial changes, then marketing economies are associated with product flexibility.

[5] Receiving stations were being used for this latter purpose even before product flexibility came to be important in the industry.

the skim milk right there. On the other hand, this would mean a duplication of equipment in the system.

Equipment duplication was troublesome, even aside from the by-product problem. In many instances different processing operations utilize similar pieces of equipment. For example, each of three different specialized plants would require heat and power equipment that could be similar in many respects. In any case these specialized plant systems contained too much equipment that was idle or under-utilized at any one time.

An answer to this problem was the multiple-operation plant, capable of producing most or all of the basic dairy products. Such a plant possesses product flexibility, it facilitates full utilization of by-products, and it allows maximum utilization of important basic equipment.[6] In addition, some economies accrue from the sheer size of such a plant. Plant managers emphasize the more efficient power plant, and also sanitation economies. "It costs about as much to clean up a milk plant as it does to operate it all day. The clean-up time is about the same whether 100,000 pounds or 200,000 pounds of milk go through."

An old problem remains. How does a firm manage to procure 100 million pounds of milk at one location during a year? It can utilize the largest route trucks that the state road laws will permit and send them far afield and/or it can utilize receiving stations where the milk is removed from the 10-gallon cans and hauled to the main plant in tank trucks. In either case, transportation costs are high. Other things being equal, additional milk volume can be secured only at the expense of higher incremental procurement costs (mostly transportation cost).[7] Eventually these higher incremental procurement costs offset the plant economies that are associated with a larger intake of milk. Beyond this point it does not pay a plant to expand its volume. A number of plants in the state appear to have reached this point at the present time.

What then is the outlook for continued consolidation of the Wisconsin dairy industry? Present trends undoubtedly will continue. Small plants with single operations, especially cheese factories, probably will continue to decrease in numbers and increase in average size. Even though cheese

[6] Of course different pieces of equipment are specialized to different degrees. Clearly the highly specialized pieces (cheese vats, driers, canning machines, etc.) are not utilized unless their particular products are being made. On the other hand the less specialized equipment (intake, heating, pasteurizing, etc.) is utilized regardless of the type of end product being made.

[7] For this reason the industry is very much interested in laws that regulate truck weights and the payloads that trucks are allowed to carry. This was made the subject of a study by the University of Wisconsin and the Bureau of Agricultural Economics, published by the latter under the title "Regulations on Weight of Motor Trucks—Problems Illustrated by Wisconsin's Experience in Hauling Fluid Dairy Products."

may continue to utilize an increasing share of the industry's milk supply, the one-vat cheese operations will tend to be squeezed out by operations employing a number of vats.

The average size of butter operations may not increase but numbers probably will continue to decline as butter assumes a progressively less important position in the industry. It is very possible that the size and number of condensery operations will not change much in the next few years. The number of drying operations may not change much but their character will depend on the success of a newly developed small scale drier. If successful it may replace much of the present roller equipment and be installed in plants that were too small to utilize the older spray drying technology.

The combination of different operations into multiple-operation plants, perhaps the most significant trend in the industry, undoubtedly will continue. Some of the present multi-plant firms will concentrate manufacturing operations at one of the plants and convert other plants now performing manufacturing operations into receiving stations. In other instances, plants may be retired from use altogether. Then, if distances are not too great, the "can routes" can be reorganized and the route trucks can haul directly to the new multiple-operation plant. Procurement costs will be the crucial influence affecting this trend.

At present there seem to be two available avenues for attacking this problem of farm-to-plant transportation costs. One possibility is bulk collection. This system eliminates the 10-gallon cans. At the farm the milk is transferred directly from the milking machines to bulk cooling tanks. A tank truck makes the rounds of the farm patrons and pumps the milk from the bulk cooling tanks into the truck tank. Under this system milk can be hauled economically[8] over greater distances than in cans. Bulk collection could enable plants to enlarge their supply areas, and perhaps eliminate some receiving stations. This would aid the trend toward large plants.

Another possibility is for plants to procure a larger share of the milk supply in their immediate vicinity. In many instances this would entail a change in the structure of hauling rates charged to the farm patrons. Theoretically, the farmers sell milk on a delivered basis; that is, the patron is supposed to bear the cost of getting his milk to the plant. Usually there is established for each route a flat hauling rate per hundredweight of milk, and each patron on the route is charged at this rate. Obviously this tends to favor the patrons who are far away from a plant,

[8] The economy of bulk farm pick-up, in contradistinction to hauling, is closely related to the volume of milk produced at individual farms. However, low priced bulk coolers and skip day collection appear to have made this system feasible in parts of Wisconsin.

and penalize the patrons who are close. In turn, this enables plants to compete more effectively for milk supplies at considerable distances, and even to solicit patrons in each other's back yards.[9] One result is a large amount of cross hauling.

If the structure of rates charged to farmers corresponded more closely to the actual hauling cost structure, then plants would tend to obtain a larger share of their milk supplies from the areas closer to them. This would result in either a net reduction in the farm-to-plant hauling bill for the industry as a whole,[10] or else more consolidation.

In any event, it seems likely that if bulk collection becomes general in the state, with an enlargement of routes and with tank trucks roaming over wide areas to pick up milk, that there must be a change in the presently existing pattern of hauling rates charged to farmers.

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CONSUMER CHOICE AND RESEARCH IN STANDARDS FOR CONSUMER GRADES*

THE purpose of this paper is to plead the case for research in consumer preference (especially for setting commodity grade standards) at a time of relative indifference in industry and reluctance on the part of many research administrators. Apparently these administrators question only the popularity of such research and not its intrinsic merits. In some administrative quarters, research in consumer preference meets with about the same approval as research in nuclear physics did about fifteen years ago. Since the study of the attributes of demand ought to be a large area of the professional field in economics, it seems that this problem should be of some concern.

Recently a principal public administrator gave a very good talk on research for setting commodity grade standards. It would be difficult to find fault with the generally accepted concept that commodity grading usually facilitates marketing, especially by clarifying agreements and thus alleviating the need for inspections. It is probable that much litigation, and economic quarrels of a less formal nature, have been avoided by government grades on commodities. On the other hand, it is too often forgotten that grades based on standards that cannot be interpreted in

[9] Another competitive device is the plant hauling subsidy; that is, only part of the farm to plant hauling charge is paid by a farmer, the balance being paid by the plant. This is a semi-hidden method of paying a higher net farm price for milk and in effect it compounds the price discrimination.

[10] In 1949 this bill amounted to between 25 and 30 million dollars in Wisconsin.

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the consumer market are confusing and actually may have an adverse effect on demand, as well as increase costs of production.

What commodities should be graded and what standards should be set are questions that should be settled through objective research. A research program of this kind must, however, postulate some criteria of value. The decision as to what research should be undertaken and also the results of the research must be evaluated in terms of these criteria.

Ultimately the principal criterion in determining what grades should be established and what standards should be used ought to be one based on consumer demand. Ordinarily it would be easy to justify commodity grades by the requests for the grades. Requests for grades and standards are not a substitute for information on the consumer demand for the products upon which the grades would be established. Measures of the demand for the product must come from consumers of the products who do not have a great enough personal interest in an individual product to bother with any request. The impetus must arise elsewhere.

During recent years there has been a flair for having industry or commodity groups help guide the direction of agricultural research. The arguments for this are that research will become more pragmatic and results will more likely be adopted by industry. Whether these advisory groups do a good job helping to direct research depends not only on their interest and knowledge of problems in the industry but also on their knowledge of research tools for solving the problems. Unless they have formal training it is very likely that they are more aware of tools of a tangible nature than they are of the more abstract research tools needed to study consumer preference or acceptance.

It might be argued by some that production and trades people are interested and have knowledge of the problems related to the nature of consumer demand. The extent to which this is true is debatable. At least the requests by these groups for research into the nature of consumer demand are not numerous. If the requests for research of this kind are not forthcoming because representatives of industry do not believe that suitable research tools exist, there is a job to be done: either revealing what does exist or developing the research tools. This ought to be the joint responsibility of the agricultural economist and the research administrator.

Perhaps competitive business feels relatively more competent in estimating and directing attributes of demand than it does in coping with the more tangible elements of costs. At least the more tangible problems may seem more real and near at hand. An element of cost may seem like a bee sting and a demand problem a type of malaise—thus bringing about an inverse relationship between the victim's response and the importance of the malady. If there is a tendency for a firm to feel competent in its

ability to estimate demand factors, it would reserve this for its area of competition. The firm would thus feel that the general ignorance of demand in the industry as a whole would be to its advantage and logically would not request research to change it, even though the net income of the industry as a whole could be increased more on the demand side than on the cost side with assumed demand.

A requested grade standard may be one that would have adverse effects. Requests may not be industry-wide. Special groups within the industry or in allied industries may ask for standards favoring themselves over their competition. Consider, for example, the problem of setting weight standards for chicken eggs. It would be conceivable to set such narrow weight tolerances that only very precise machinery would sort eggs within standards. Farmers or small dealers, who for volume reasons could not afford the needed machinery, would either have to stay much above minimum weights to be on the safe side or not claim to sell standard eggs. Could there logically be requests for standards of this kind unless consumers want the protection? It is logical that there could be and that the standard would have adverse effect on demand as a whole and would increase the costs of marketing. Not only is this logical, but it probably exists to a real degree.

In West Virginia a large sample of the state's homemakers were interviewed to learn their opinions on services and characteristics related to eggs. One of the questions, aided by an exhibit, sought to learn opinions on variations of the sizes of individual eggs. In view of the responses to this question it seems that the federal standards for weights of individual eggs—presumably standards that have been demanded—cannot be sensed by consumers. A significant percentage of the respondents said they liked their eggs to be uniform in size but actually they could not distinguish varied sizes from uniform sizes to any degree such as required in the federal standards. Eggs handled by retail stores in the state were also studied. Evidently retailers were more concerned about their customers than they were about specifications for standards if these specifica-

TABLE 1. EGG WEIGHTS FOUND BY INSPECTORS COMPARED WITH RETAILERS' CLAIMS FOR WEIGHT WHEN JUDGED ON DOZEN-WEIGHT STANDARDS COMPARED WITH STANDARD WEIGHTS FOR INDIVIDUAL EGGS

How the actual weight found compared to the weight claimed	Distribution of 100 stores judged on two different bases for grading egg weights	
	Judged on dozen-weight standard only	Judged on standards for weights of individual eggs
Below	5	22
Same	91	76
Above	4	2

tions were not demanded by their customers. Table 1 shows that 22 per cent of the stores sold eggs that did not meet requirements for individual egg weights whereas only 5 per cent were below the dozen-weight requirements.

The problem of finding grade standards comprehensible to consumers is not one peculiar to egg sizes. It probably exists in any commodity, and the more attributes involved the more intense the problem. Take, for example, another relatively simple problem in setting an egg quality grade on a dozen eggs. Which is the better dozen—(1) having 10 AA's and 2 B's, or (2) having 12 A's? The question needs to be settled if a grade is to be given the whole dozen. However, the difference may seem unimportant. The decision ought not be arbitrary because the effect may be quite important in changing marketing channels. Dozen 1 is quite likely to be one that has not been in the wholesale channels whereas dozen 2 is likely to have been sorted for quality. If a higher grade were assigned dozen 1, more direct marketing would be encouraged. Generally a greater tolerance for variation in quality within a grade would have this effect.

The demand for grades embracing narrow tolerances for quality variation is not likely to come from the farmer producing a relatively variable product. It may come from the consumer. However, it is more likely to come from groups specializing in measuring quality differences or from industries producing equipment for such measurements. It can come from agencies and institutions training personnel for such measurements or having invested heavily in personnel already trained. To some of these agencies or institutions, research results that indicate no need for the measurement of certain attributes may become embarrassing. It would thus be better that the research would be done by others. To evaluate this demand for specific grade standards it is necessary to study the underlying interests of those making the demands.

A wholesale grade should not be confused with a consumer grade. The two may be related but it is entirely possible to have functional wholesale grades that may merely be confusing to the consumer.

Even though it may pay for them to do so, those engaged in the production and marketing of commodities do not reflect the nature of the demand, except in a rather imperfect manner. If the misconception of demand is industry-wide there is no way to learn of this in the regular marketing channels unless somebody makes a mistake. Again using eggs as an example, the trade accepts as a fact that Boston is a brown-egg market and New York is a white-egg market. This has led to price differentials between the colors in both cities. In Boston more brown eggs are sold at a higher price and in New York more white eggs. Does this mean that there is a basic preference for color in either city? Not necessarily.

If consumers see one article priced higher than another in competition with it they will often buy the higher-priced article, assuming that the vendor has the same degree of integrity in either case. (This is one of our real difficulties in controlled experiments studying consumer preferences as measured by price differentials in established stores.) They feel that something beyond their understanding makes the higher-priced article better. So in the case of brown versus white eggs the customer may be buying additional vendor's integrity rather than color. Of course, if the vendor does not have the knowledge the integrity does not exist. Although we have not studied consumers in the two cities mentioned we have found it true from household surveys in other cities that consumer opinion on egg color did not agree with trade opinion.

A recent report of an industry advisory committee calls for what it terms more fundamental research. Their report calls for more emphasis on reducing costs and maintaining quality. We inferred that the quality was to be measured by orthodox methods, and that research into consumer preference and acceptance might almost be viewed with misgivings. Certainly, learning what quality to maintain in order to maximize a net value is at least equally as fundamental as learning how to maintain quality to postulated standards. It is also true that costs might be reduced by seeking quality attributes and determinants more nearly related to the market demand, more precisely, consumer demand.

Perhaps classical economics with its emphasis on production and its assumed demand is an inherency of the concerted confusion of a war-geared economy. Assuming a *total* demand at such times may not be greatly in error. In our two most recent major wars our government resorted to food substitutes and to price control and rationing. So long as we want to allow consumers a degree of choice in consumption, consumer preference necessarily becomes an important element in any rationing program. Assuming the nature of demand from observation of the established market is a great error, because this is based on misconceptions of trade and arbitrarily imposed standards. A situation of this kind will not maximize consumption value in terms of costs, and reductions in costs can be studied properly only in terms of output. The output must be submitted to the subjective valuation by consumers. Research in consumer preference and acceptance should accelerate and economize the slow and costly trial-and-error system of trade.

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BOOK REVIEWS

Agricultural Prices, New Second Edition, F. L. Thomsen and R. J. Foote: McGraw-Hill Book Company, 1952. Pp. xi, 509, $6.50.

This is a revision of Thomsen's widely used book of 1936 by the same title. The general form has been retained, namely a division into three distinct parts: price principles, analytical methods, and the price behavior of specific commodities. These three have proved a good tripod on which to build an understanding of agricultural prices. Like the earlier work, this book is primarily a text aimed at the junior or senior undergraduate level. It could also be used as a reference book by people variously interested in prices. The present treatment is somewhat more technical than the earlier version.

Distinct changes have been made in all three parts of the book. These changes are most evident in the first section, dealing with price principles. Here the book is no longer depression oriented as was its predecessor. Chapters have been added on aggregative price behavior, pricing under imperfect competition, and the business cycle. The chapter on government price programs has been greatly expanded. Considerable effort has been made to keep this material lucid. Nevertheless, the going gets a bit heavy at times. Most of the business cycle theories and the various theories of the value of money come in for at least a cursory examination. Thomsen and Foote have tried to keep this all accurate and comprehensive, and at the same time brief and clear. This is a great undertaking for a book which also aims to cover methods of price research and price behavior in particular areas.

The second section, on analytical methods, has also been expanded. As before, there are chapters on sources of data, index numbers, correlation, both simple and multiple, trends, cycles, seasonal variation and price forecasting. The section has been almost wholly rewritten. The treatment is as clear and comprehensive as the scope and complexity of the subject permit. The new edition is much more scholarly than the old in this section. The junior author, Foote, is an agricultural statistician, and it is in this section that the hand of Foote is most clearly seen. The authors tackle problems without special concern for a high degree of refinement. This is apparent also in the first section, where a defense is made for the use of straight lines as representative of demand curves.

The section on prices of particular commodities bears closest resemblance to the first edition of the book. A new chapter on fats and oils has been added. Results of recent price research are included. Throughout this section, factual material regarding commodity prices is presented in such a manner as to illustrate the principles appearing in early chapters. The effect of this approach, from the experience of this reviewer, is to

drive home the principles of price while the student thinks he is studying hogs and wheat. This technique may have helped account for the success of the first edition.

Charts used in the book are well chosen, clear, and numerous, totaling 122. The tables presented are pertinent, brief, well composed, and number only 16. The narrative is in Thomsen's characteristic style, with occasional quips which help lighten a difficult subject. Thomsen's interest in marketing in recent years has been an aid in the rewriting of this book on prices.

One is impressed, in comparing the 1952 and the 1936 edition, with the differential rate of development in the three areas into which Thomsen and Foote divide their book. To the principles of price, the elapse of sixteen years has added the aggregative approach, imperfect competition, and the whole complex of ideas emanating from Keynesian economics and the business cycle. With respect to methods of analysis the elapse of time reveals changes which have been more moderate but nevertheless substantial. In the third section, the past 16 years have added relatively less to the body of knowledge regarding the price behavior of specific commodities.

This book probably contains more material than can be well covered in a one semester course. Different instructors may wish to emphasize different parts. Nevertheless, it is probably well to have a view of the entire area included in a single book.

DON PAARLBERG

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Agricultural Price and Income Policy, Geoffrey S. Shepherd. Ames: The Iowa State College Press, Third Edition, 1952. Pp. x, 288.

This is the second revision of Professor Shepherd's well-known price policy book. In comparison with the preceding edition, there is some addition, much subtraction and considerable rearrangement of material, and as a text it is a different book. But as an approach to an important economic question of our society it remains about the same, for the author's views of how we should handle farm price and income problems have not changed much. Though this is certainly to be expected, it is a little less than suggested in the preface where the United States' new role in the world and the likelihood of prosperity for several years are emphasized as reasons for a shift in policy recommendations.

The second edition was divided about half and half between a detailed discussion of past and present programs and a presentation of a five-point program for the future. In this edition, the first half is replaced by a much shorter discussion of the setting for agricultural price and income problems, while the presentation of the five-point program is expanded

by about one-fourth. The result is an improved text: the student is given a better perspective on the price and income problems with which policy deals, and the exposition of the five-point program moves along in a more positive and better balanced fashion than before. The second edition still remains valuable for its wealth of detailed information about experience with farm price programs prior to 1947.

Professor Shepherd names three principal price and income problems of agriculture: the short-run instability of prices and incomes, the long-run level of farm income and the distribution of income among farmers. He attributes instability chiefly to changes in disposable income and to variations in supplies of farm products, and he is critical of price as a regulator of production and consumption in the short run. He discusses at some length how real incomes of farm and non-farm people compare and concludes that farmers are not at a disadvantage except in times of depression or in areas where inadequate farm units predominate. He describes the great differences among individual farmers' incomes and severely criticizes the unqualified use of income aggregates based on the census definition of a farm.

After a review of past experience that does not give high marks to the CCC withholding program, to production control or to price supports for perishables, Professor Shepherd names five objectives for price and income policy. These are: reduction of price uncertainty; reduction of instability resulting from variation in supplies, from erratic production on individual farms, and from changes in demand; and improvement of the long-run level of farm income. Several specific programs are discussed as means of attaining these objectives. Some of the programs are alternative means of attaining a single end, and although all have some merit the author expresses reservations about certain of them.

Forward pricing is discussed as a means of reducing price uncertainty, but a need is expressed for better techniques of forecasting if the method is to be effectively used. A proposal for protecting feed grain prices, and indirectly certain livestock prices, against variations in supply is described with more confidence in its success. Similar protection for wheat and cotton is considered less necessary, and variable loan rates are suggested for these commodities. A modification of present crop insurance is advocated to deal with weather and other hazards on individual farms.

Consumption subsidies are discussed, on the whole favorably, as means of reducing instability arising from variable demand. Compensatory price and income payments are also described in this connection, and the author goes somewhat further in raising objections about administrative difficulties and equity among producers than do most proponents of these plans. As a third attack on instability arising on the demand side, the author renews his proposal for taking money from farmers by high income or processing taxes in prosperity and returning it in depression.

The book closes with chapters on under-employment in agriculture and on the long-run level of farm income. Improvement of the latter, Professor Shepherd says, depends on correction of the former. As he aptly puts it, "The units whose 'prices' (incomes) are low are farmers, not farm commodities." He favors an approach based on education, assistance to migrants in finding non-farm work, consolidation of inadequate units where feasible, and the like, to promote equality of income between farmers and non-farmers doing work requiring similar skills.

Some suggestions for a fourth edition a few years hence come to mind. First, the triad of basic price and income problems is too narrow a base for the policy structure; the base needs to be broadened at least to include resource allocation, which in the present arrangement is dragged in by the ears without adequate discussion. Second, because the list of policy objectives is a tidy collection of consistent and reasonable ends, it fails to suggest the inconsistent and sometimes unreasonable character of objectives that motivate participants in the actual policy making process. Thus questions of how to resolve conflicts of objectives are hardly raised, and the clash between income and resource use objectives, which may well be the most important farm policy issue of today, is largely submerged. And finally, the author's summary dismissal of the idea that agriculture is disadvantaged by the competitive conditions under which it operates is not convincing; this question needs a clearer analysis than it has received to date.

But who can write a book, especially on farm policy, that completely suits everyone? This book is so clearly written, so temperate and generally so firmly based on economic analysis of policy issues that it is an outstanding work in its field.

G. E. BRANDOW

The Pennsylvania State College

Beet Sugar Economics, R. H. Cottrell, Editor, Caldwell, Idaho: The Caxton Printers Ltd. 1952. Pp. xi, 379. $5.00.

"Beet Sugar Economics" as a title, implies an emphasis upon economic analysis and interpretation of the beet sugar industry. This book comes more nearly to being "Beet Sugar Production and Marketing." The editor handles a dual role as he is also author of parts of the text.

As author, Cottrell stresses the problems facing the United States sugar industry due to higher wage rates in the United States than in other countries. Thus, although sugar beet production compares well with other domestic farm crops in relative efficiency of farm labor, as measured by relative price plus government payments in the highly protected United States market, it is produced in other countries with labor wage rates far below those in the United States. However, sugar production fits in well with western irrigation farming. These conditions set the stage for the

continuous presence of sugar legislation, in the form of tariffs and subsidies, on the statute books of the nation.

Cottrell is at his best in explaining the factory production of sugar. He is vague when discussing profit, giving neither adequate illustration nor methods of calculation. He is likewise vague in analysis of costs either in the factory or on the farm.

With the wealth of Land Grant College studies of sugar beet production available for his reference, he is content to cite "the records of a beet sugar company farm operation" as his only reference to the farmers' costs of producing sugar beets. Sugar beet processing corporations are scarcely representative sugar beet producers. An illustration from their operations would seldom indicate the situation on farms. Since this illustration gives neither quantities of labor, cost rates, nor dates involved, it fails to inform the reader as to farm cost problems.

Similarly, the review of company manufacturing costs merely itemizes the subdivisions of factory cost but gives no clue as to what these costs might be under any given set of conditions except to say (p. 134) "the cost of beets delivered at the factory represents, typically, about 75 percent of the total. The amount paid to the grower for beets, represents over 65 percent." Since this ratio can be true only for a given volume of business, and for a given set of prices for beets, labor and materials, it offers the reader but slight evidence of company costs. True, a set of assumed conditions of factory operations are given but the reader is left to make his own calculations as to the factory cost per cwt. of sugar under these assumed conditions. The only clue is an excellent summary of the effects upon cost of a reduction in the daily run of beets.

The reader will find considerable information in the discussion of factory extraction, storage of raw beets, and general conditions of farm production.

Part IV, "The Sugar Market," contains a good description of the market. It emphasizes the international and political importance of sugar. It summarizes United States tariff legislation and the major sugar acts. It discusses sugar marketing methods, giving explanations of the origin and purpose of each important step in the marketing process.

The reader will find much valuable information in this book, but he will find that it fails to live up to its title "Beet Sugar Economics" except in the section on "The Sugar Market."

R. T. BURDICK

Colorado Agricultural Experiment Station

Farming and Democracy, A. Whitney Griswold. New Haven: Yale University Press, 1952. Pp. ix, 227. $3.00.

This little volume was first published in 1948 by Harcourt, Brace and Company and has now been reissued by the Yale University Press. During

the interim the author became President of Yale, an event of some significance in view of the breadth and perceptiveness of Mr. Griswold's mind.

Griswold sets out to examine the idea "that farming as a family enterprise is the 'backbone of democracy'." He winds up with the conclusion that whatever its skeletal role in Jefferson's time, the family farm today is scarcely more than another vertebra, and probably a lower one at that. This alarming shrinkage, the author believes, is a natural consequence of the trend toward urbanization which has continued unabated in this country for some 200 years. "Reduction of the farm population," he notes, "has proved itself a corollary to economic progress in all of the industrialized or partially industrialized countries."

Beginning with a neatly composed, if somewhat cynical, introduction, Griswold appraises agricultural policy in terms of the Jeffersonian ideal and the British, French, and American developments, concluding with a look to the future in this country. His chapter on Jefferson is especially noteworthy. Jefferson's agrarian bent and his advocacy of widely distributed rights in property are well known. What is less generally understood is that Jefferson's grand purpose was the nurturing of an untried system of government; and that his insistence on family farms derived from a belief that property-holding by large numbers of citizens provided the safest assurance of the survival of democracy. His attacks upon primogeniture and entail, as well as his suggestion for a graduated land tax, had the same motivation—the buttressing of political freedom in the New World. A realistic idealist, Jefferson was retreating from his claims of the paramount importance of agriculture long before his death, as the growth of industry in the states began making its inroads on the farm population.

In Great Britain the exponents of small, family-operated farms have fought a stubborn but losing battle through the centuries, and today British farms support the smallest proportion of the national population of any country in the world. Moreover: "Democracy did not flourish in England until the political power of the agrarian aristocracy had been broken and British agriculture had been deliberately discarded as a way of life."

In France the peasant proprieter was more tenacious. Aided by a near-stable total population, the French peasant has beaten back every large-scale attempt to combine small holdings, or to destroy equal devolution, and with it, his way of life. "Great Britain ignored the Jeffersonian ideal. France distorted it." Democracy flourished in France ". . . in spite of the agrarian community rather than because of it."

In America there was a paradox: "Rich or poor, productive or unproductive, the overwhelming majority of American farms continued to be operated as family ventures." Yet, "A self-sufficient farm in our time is more likely to be a haunt of illiteracy and malnutrition than a wellspring

of democracy." The truly great service performed by the family farm, according to Griswold, is either past or passing: "The public land laws were conceived in the Jeffersonian tradition. They kept alive (democratic) principles in the fat years, when land was plentiful, for reference in the lean years, when it was scarce."

Farming and Democracy is the kind of analysis that needs to be hurled at agricultural economists like a series of cavalry charges. For, when his work is viewed through fundamentalist eyes, Griswold reveals two serious faults. In the first place, he can write. In agricultural economics, this effete tendency comes perilously close to being the Original Sin. Good, lively writing is produced so rarely by the craft that in some quarters scientific method and dullness have been twisted into synonyms. He who rocks this drab semantic boat is asking to be tossed overboard, to drown professionally, while his word-grubbing associates cry "Journalist!" and continue bailing furiously with their sturdy two syllable buckets.

Griswold's second fault is worse than his first. He is not an agricultural economist, being merely a specialist in English, history, government and international relations. Hence, he is an intruder who has never known the titillation of the agrarian folklore. Being neither farm-bred nor land-grant trained, Mr. Griswold sometimes carelessly departs from the principle that rural living unfailingly constitutes the best of all possible worlds. Maybe, with such heretical foundations, he was wise in retreating to the oblivion of university administration.

Despite these departures from the norm, Griswold's work is methodical and scholarly. If he has any special difficulty, it is of an order that is both congenital and epidemic; namely, an inability or unwillingness to place a consistent and understandable meaning upon "family farm." Vacillation between "agrarian aristocracy" and self-sufficiency as conceptions of family farming inevitably terminates in mixed results. Nevertheless, his closing statement (unfortunately, too long to quote) is a moving tribute to the American goal and is easily worth the price of the book. The gist of it is an appeal to agricultural policy-makers for the substitution of reasoned judgment and statesmenship for special-interest bias.

JOE R. MOTHERAL

Bureau of Agricultural Economics

City Milk Distribution, R. G. Bressler, Jr., Harvard University Press, Cambridge, Mass., 1952. $6.00.

The distribution of milk has been subject to a great deal of discussion and criticism for the past half century in the United States. The "high cost" of milk distribution has been attributed to many factors, but usually the blame comes down to an excessive number of too small processing plants and the multiplication of delivery routes as a consequence of the competitive nature of milk distribution. In his book, Prof. Bressler provides a method of analysis which can be used to indicate the reductions

in costs that could be achieved by various rationalizations of the milk delivery system. He applies his method to four different modifications of the milk distribution system: (1) exclusive delivery territories to private firms, (2) municipal milk distribution, (3) elimination of home delivery, and (4) alternate day delivery. The last of these modifications—alternate day delivery—has remained in most milk markets after it was adopted during World War II as an emergency conservation measure.

Bressler's estimates of costs under various systems of milk distribution are based upon an analysis of existing firms and of engineering cost data. His analysis of the existing structure of costs is based upon a combination of regression analyses and time studies. In his regression analyses Bressler is careful to estimate relations between inputs and outputs for quite discrete and homogeneous activities. Thus his analysis of delivery truck costs includes the following input items—gasoline, oil, tires, repairs, depreciation, general garage and storage, insurance, taxes and interest. Where necessary, the make and type of truck and age of truck were analyzed separately. His major objective was to determine truck costs as a function of distance travelled, time used, and make and type of truck. This type of analysis gives a much better view of the significant components that affect truck costs than any estimate of annual average costs or of average costs per mile.

Much of the analysis of delivery labor costs was based upon time studies of actual delivery. Again, by breaking the delivery operation into its component parts—delivering, collecting, driving, and other—it was possible to determine the effect of different route organizations upon delivery labor costs.

The estimates of plant costs were based upon engineering data for six different sized small plants and actual costs for larger plants.

Given the various input relations that are involved, Bressler turns to an estimate of the costs of various delivery systems. For the major Connecticut markets, he estimates that alternate day delivery results in about a 28 per cent saving compared to daily delivery. Exclusive territories, with alternate day deliveries, would reduce distribution costs by 25 per cent and municipal distribution by 40 per cent compared to the present system with alternate day deliveries.

While Bressler's estimates of savings resulting from alternative systems seem quite reasonable, it is difficult to explain why no major milk market has ever been completely served by one firm. If the savings from increased volume and concentration of milk delivery were so significant, why has not the largest firm continued to grow until it served the entire market area? In fact, numerous instances may be found in which the share of the market served by the largest firm has been reduced by competitors. This is the converse of what one would expect if the economies of scale of plant operation and of the concentration of delivery volume were as great as indicated by Bressler's work. I am sorry that Bressler did not

consider this aspect of his analysis. I suspect that part, though far from all, of the answer may be found in the fact that some of the resources used in milk processing and delivery have low alternative costs. This is certainly true of producer-distributors. But this can not be the whole explanation because producer-distributors have almost disappeared in the large urban areas.

While I believe that Bressler exhibited insight and discrimination in the development and application of his analysis of the input relations in milk distribution, I must register a mild dissent to his approach to the measurement of consumer demands and preferences. Consumers were asked to indicate the difference in the price of milk that would make them indifferent between different delivery systems. Only in the comparison of the alternate day and daily delivery did the consumer have any basis in experience for arriving at such an estimate. But for the comparison of the present system with exclusive dealer territories or a municipal monopoly, the consumer was not in a position to evaluate the consequences of the alternative action. In fact, Bressler points out that surveys of consumers with respect to alternate day delivery found the consumers quite apprehensive of the consequence of the change and most consumers indicated that the savings would have to be large before they would be satisfied. However, after alternate day delivery was a fact, a majority of the consumers would have been unwilling to pay any extra for daily delivery. On page 338 Bressler generalizes that consumers are "overconservative in forecasting their reactions to new and changed conditions" because consumers were quite reluctant to accept alternative day delivery. But I believe that an alternative conclusion is equally justified—namely, that such consumer surveys do not provide a reliable indication of consumer reaction.

Bressler has given us a very good book about the production aspects of the marketing process. His efforts have shown that the production aspects of marketing and distribution are important and interesting. His book will lead the way, I hope, for somewhat greater sophistication in the analysis of production problems in the marketing sector. Such a development has been sorely needed.

D. GALE JOHNSON

University of Chicago

Agricultural Cooperatives in Czechoslovakia, Ladislav Feierabend, New York: Mid-European Studies Center, 110 West 75 Street, New York, 1952, pp. 125. $1.00.

Agricultural Conditions in Czechoslovakia, 1950. William Horbaly, Chicago: University of Chicago Press, 1951, pp. 103. $3.00.

The people of Czechoslovakia, the "Little America of Europe," have in recent years witnessed many tragic changes. Despite a theoretical immunity to Communism, a socialist state has been established.

Dr. Feierabend is a well-qualified interpreter of the developments in the realm of agriculture in general and of agricultural cooperatives in particular. Before World War II, he was the Chairman of the Czechoslovak Grain Monopoly, which in many respects can be compared to the CCC. During the first two years of the War, he was Secretary of Agriculture in Prague, and later on Secretary of the Treasury in Dr. Benes' Exile Cabinet in London. Each line of the publication bears witness to his intimate knowledge of the subject.

In *Agricultural Cooperatives in Czechoslovakia*, he traces the development of the cooperative movement over the last 100 years. Then an analysis of cooperatives in the Czechoslovak economy is undertaken. Dr. Feierabend is thorough and specific about explaining the role of the different types of cooperatives. He emphasizes that the movement was not only concentrated in the agricultural sector of the economy but that urban consumer co-ops were also important. This constitutes one of the major differences between Czechoslovakia and the United States of America where supermarkets rather than consumer cooperation have developed.

The account of the World War II period, under German occupation, gives us a basis for comparison with the later developments under another type of totalitarian government—Communism. Although one has no sympathy left for either of the dictatorships, it still appears as if the Nazis have behaved a shade more businesslike. The chapter on postwar Red infiltration and the final coup d'etat culminates in the account of the legislation providing for Unified Agricultural Cooperatives (UAC's)—the tool by which the independent Czech farmers are to be forced into virtual slavery.

Dr. Feierabend concludes that true cooperatives cannot be tolerated by Communism—a philosophy of subservience rather than freedom, social class hate rather than understanding, aggression rather than tolerance, coercion rather than mutuality. There can only be a "cooperative system," created by acts of the government and dependent on it. If a member cannot freely decide whether to join or leave an association, then the organization to which he belongs is neither voluntary nor autonomous. It is not a cooperative in the sense of the Western definition of the term.

The reviewer is willing to agree with the author in all conclusions but one: "The destruction of the cooperatives has had consequences fateful to the national economy of Czechoslovakia. Agricultural production has decreased rapidly." No doubt that both sentences contain parts of the truth. But the sequence would seem to imply that the destruction of the true cooperatives has caused a fall in production of agricultural commodities. That is a very unwarranted simplification, which might easily mislead the unsuspecting reader. The expulsion of over 3 million Germans and Hungarians after World War II, many of whom were farmers,

has probably been more effective in cutting the production than anything the Communists have undertaken since February, 1948.

Another criticism is that the author's thoroughness makes for slow reading. The statistical tables, with some few notable exceptions, are based on "ancient" sources. The style is in parts scholarly, heavy, and dry. This shortcoming is made somewhat more bearable by the up-to-dateness of the problems discussed.

In connection with the general discussion of the collectivization question, William Horbaly's *Agricultural Conditions in Czechoslovakia, 1950* can serve as an excellent background-provider. This publication is an outcome of a professional geographer's on-the-spot investigations in 1950 as Fellow of the Institute of International Education, with residence at Charles University in Prague. Dr. Horbaly gives a thorough description of the four major agricultural production "belts" of the country (sugar beets, grain, potatoes, and grazing) and tries to explain the differences in regional agrarian problems. Policy is thus put on an ecological base.

In Chapter IV (Agriculture and Socialism), there is an extensive quotation from policy statements on collectivization made in 1950 by Rudolf Slansky, the now liquidated Secretary General of the Czechoslovak Communist Party. Horbaly first discusses the general objectives of UAC's. Then he tries to illustrate the gradual socialization procedure by a detailed analysis of eight individual UAC's. The sample is by no means random. "Field studies of individual farm units and agricultural villages were carried on under somewhat confining circumstances and are, therefore, neither systematic nor complete." (V) Even under these limitations Horbaly was able to get hold of extremely illuminating accounting data, showing how costs and profits are allocated among members of a specific UAC. These case investigations then, although not normally recognized as appropriate tools of similar inquiries, give the reader the best insight available under the circumstances and thus supplement nicely Dr. Feierabend's book.

Dr. Feierabend has just finished another book which deals with the administrative procedures applied by the regime in managing the socialized agricultural sector of the Czechoslovak economy. This book will also be published by the Mid-European Studies Center, an agency of the National Committee for a Free Europe. The Committee should be commended on presenting these scholarly efforts which help to enhance our knowledge and understanding of Soviet Russia and her satellites. The more we know about our rivals, the better chance do we have of coping successfully with the present foreign policy problems.

FRANK MEISSNER

University of California

NEWS NOTES

William H. Alexander, who was on sabbatical leave from Louisiana State University during 1951-52, returned to his duties as Associate Professor in the Department of Agricultural Economics on September 1, 1952. During his leave he took advanced work at the University of Illinois.

Fred B. Anderson, has been appointed Assistant Agricultural Economist at Alabama Polytechnic Institute where he will study cottonseed marketing. He is taking the place of R. Wayne Robinson, who is on leave to continue his graduate work at the University of Wisconsin.

George H. Aull, Head of the Department of Agricultural Economics and Rural Sociology at Clemson College, has been appointed to the National Planning Association's "Committee of the South."

Charles E. Botterbusch assumed the duties of fieldman on November 1 with the Sangamon Valley Association of the Farm Bureau Farm Management Service in Illinois.

Donald L. Brooke has resumed his work as Associate Economist at the Florida Agricultural Experiment Station after a year of graduate study at the University of Illinois.

Aubrey J. Brown has been appointed Head of the newly created Department of Agricultural Economics at the University of Kentucky. He was formerly Head of the Department of Markets and Rural Finance. The new department represents the consolidation of this department with the former Department of Farm Economics.

Ralph Campbell has been appointed Head of the Department of Agricultural Economics at Ontario Agricultural College.

George L. Capel has resigned from the Cooperative Research and Service Division, Farm Credit Administration, and has enrolled in the Graduate School of the University of Florida. He is working toward a Ph.D. degree in Economics.

Paul C. Clayton, Research Assistant in the Department of Poultry Husbandry at Ohio State University, has accepted the position of Poultry Marketing Extension Economist with the Agricultural Extension Service of Nebraska, effective December 1.

A group of 27 economists representing seven foreign nations recently completed a two weeks short course in agricultural credit at the Clemson Agricultural College. Delegates were in attendance from Belgium, Denmark, France, Greece, Italy, The Netherlands, and Yugoslavia.

The following staff members in the Department of Agricultural Economics and Rural Sociology at Clemson College were recently promoted to Associate rank: L. M. Bauknight, V. A. Boyd, L. D. Malphrus, B. J. Todd.

Frank H. J. Dickmann has joined the staff of the Department of Agricultural Economics at Oregon State College as a full-time Research Assistant. He will be working on a special study of the cost of producing Grade A milk in various sections of Oregon.

B. A. Dominick, Jr. recently joined the Cornell University staff as an Assistant Professor. He is working in Fruit Marketing Extension.

W. M. Drummond has resigned as Head of the Department of Agricultural Economics, at Ontario Agricultural College, Guelph, to accept an appointment on the U.N.K.R.A. commission which is making recommendations for the rehabilitation of South Korea.

J. Normal Efferson, Department of Agricultural Economics, Louisiana State

University, was on leave as a Research Consultant for the Consejo de Bienstar Rural of Venezuela during part of May 1952 and during the months of August and September 1952. In Venezuela, he completed an economic appraisal of the rice industry of that country and made an over-all study of agricultural marketing problems. He returned to Louisiana on October 1.

Larry D. Erlewine has been appointed Assistant Professor at Kansas State College to supervise research in Livestock Marketing.

W. James Foreman has completed requirements for the Ph.D. degree in Agricultural Economics at the University of Illinois and has entered the Air Force.

E. L. Gasteiger, in charge of the Pennsylvania Office of Agricultural Estimates, Bureau of Agricultural Economics, retired on August 31. Dewey O. Boster, formerly in charge of the Trenton, N.J. office, has been appointed to succeed him. Clifford Sims has replaced Mr. Boster at the Trenton office.

Alan Goldman has been appointed Assistant Professor in Marketing at Kansas State College.

James R. Gray, Agricultural Economist for the Bureau of Agricultural Economics, who has been stationed at Montana State College since 1949, has been transferred by the Bureau of Agricultural Economics to New Mexico State College at Las Cruces. While at Montana State College, Mr. Gray completed two bulletins dealing with organization costs and returns on family sized sheep ranches and cattle ranches in Northern Great Plains from 1929 to 1951. He will undertake similar research at the New Mexico State College.

John R. Greenman, Professor of Agricultural Economics at the University of Florida, is on a year's leave for graduate study.

George D. Harrell has been appointed to succeed John A. Hicks, deceased, as Head of the Specialty Crops Section, Division of Field Crop Statistics, Bureau of Agricultural Economics.

Robert W. Harrison and Lawrence W. Haynes have transferred from the Agricultural Statistician's Office of the Bureau of Agricultural Economics in Boston to the Division of Dairy Statistics in Washington, D.C., where they will work on prices and consumption of fluid milk and cream.

H. A. Henderson has been appointed Assistant Agricultural Economist at Alabama Polytechnic Institute. He is studying the production and marketing of eggs from commercial flocks of poultry in Alabama.

Peter Henderson recently completed the requirements for his doctor's degree at Cornell University. He is engaged in a poultry and egg marketing research project undertaken cooperatively between Cornell University and the Bureau of Agricultural Economics.

John A. Hicks, in charge Special Crops Section, Division of Field Crop Statistics, Bureau of Agricultural Economics, died of a heart attack on September 14. Mr. Hicks had worked for about 30 years in the Virginia and Washington, D.C. Offices of Agricultural Estimates. At one time he headed the Virginia office and for several years he was Secretary of the Crop Reporting Board.

James R. Hoath was appointed Assistant Professor in Agricultural Economics at Kansas State College on September 1. He will teach Market Prices and do research on demand and prices of farm products.

Roy E. Huffman, Montana State College, has completed the manuscript for his book entitled *Irrigation Development and Public Water Policy*. It has been accepted by Ronald Press and is scheduled for publication in late summer, 1953.

Lewis P. Jenkins is on leave from Mississippi State College. He has a grant from the General Education Board to do graduate work at Iowa State College.

Maurice D. Jones of the Department of Agricultural Economics and Farm Management at the University of Maine has been granted a leave of absence for the college year 1952-53 and will be at Blacksburg, Virginia.

Arthur Kantner has accepted a position in the Research Department of the Federal Reserve Bank at Atlanta, Georgia.

E. E. Kern has returned to Mississippi State College following a year of graduate study at the University of Kentucky.

Kenneth Laurent is working at the Alabama Polytechnic Institute as Cooperative Agent in poultry and egg marketing research for 9 southern states and the Bureau of Agricultural Economics.

Clayton P. Libeau, who received his doctor's degree from the University of Wisconsin in 1952 and who was formerly Assistant Agricultural Economist with the University of Idaho, began his duties as Extension Economist in Market Organization with the Nebraska Agricultural Extension Service on September 1, 1952.

John McCoy will resume his duties at Kansas State College on February 1 after a year and a half spent in graduate study at the University of Wisconsin.

Joe R. Motheral, Associate Professor, Department of Agricultural Economics and Sociology, Texas A. & M. College, has been granted a year's leave of absence to work in the Division of Farm Population and Rural Life, BAE, as acting head of the Farm Labor Section.

Mardy Myers transferred from the Division of Dairy Statistics, Bureau of Agricultural Economics, to the Statistical Standards Section in the Office of the Comptroller of the Army.

Robert Pelley has been appointed Assistant Professor in the Department of Agricultural Economics, Ohio State University.

Joseph C. Podany has resigned from North Dakota State College to accept a position with the Rural Electrification Administration in Washington, D.C.

Levi A. Powell has joined the staff of the Florida Agricultural Experiment Station as Assistant Economist.

Norris T. Pritchard is serving as acting head of the Dairy Section of the Division of Marketing and Transportation Research in the Bureau of Agricultural Economics, U. S. Department of Agriculture.

S. T. Rice, who received his Ph.D. degree in Agricultural Economics from the University of Illinois in August 1950, has been released from the Army and has joined the firm of Longstree-Abbott and Company in St. Louis.

Harold M. Riley joined the staff at Michigan State College on January 1, 1953.

Job K. Savage has accepted a position in the Fruit and Vegetable Section of the Cooperative Research and Service Division, Farm Credit Administration. Mr. Savage has been enrolled as a graduate student at the University of Wisconsin.

Luke M. Schruben became Chief of the Division of Business Administration in the Extension Service on November 10, 1952. For the past two years he has been in charge of the Meat Animals, Dairy and Poultry Marketing Section, Division of Agricultural Economics of the Extension Service.

Raymond C. Scott joined the staff of the Division of Agricultural Economics, Extension Service, Washington, D.C., at the end of June 1952. He is in charge of the Fruit and Vegetable Marketing Section. Dr. Scott has a background of extension experience in New York State and of teaching and research in fruit and vegetable marketing at Ohio State University.

Milton Shufflet will be with the staff of the Bureau of Agricultural Economics for a year under the Bureau's research interneship program. He is working on a research project on the demand and price structure for selected vegetables.

Cecil N. Smith, formerly with the Virginia Agricultural Experiment Station, is now Associate Economist with the Florida Agricultural Experiment Station.

Robert Smith recently completed the requirements for his doctor's degree at Cornell University. He has accepted a position as coordinator of the Young Adult Program at Cornell.

John H. Southern, Agricultural Economist, BAE, has returned from a 15-month assignment in Rome as the Technical Assistance Officer for the Land and Water Use Branch of F.A.O. While on this assignment, he served 3 months as F.A.O. Mission Chief in Pakistan. Mr. Southern is stationed at Texas A. & M. College with the Division of Land Economics.

O. C. Stine is special lecturer in Agricultural Economics at the University of Florida for the second semester of the 1952-53 term.

Robert Smith recently completed the requirements for his doctor's degree at Cornell University. He has accepted a position as Assistant Professor of Marketing at Cornell and is working in Dairy Marketing Extension.

Earl R. Swanson has joined the staff of the Department of Agricultural Economics at the University of Illinois as Assistant Professor. He received his Ph.D. degree from Iowa State College in March 1951. Since July 1951 he has been on active duty in the Army serving in the office of the Assistant Chief of Staff, Logistics.

Thomas E. Tramel is on leave from Mississippi State College. He has a grant from the General Education Board to do graduate work at Iowa State College.

Andrew Vanvig has been appointed Assistant Agricultural Economist at the University of Arizona. He will work in the general fields of farm management and farm credit. Dr. Vanvig received a Ph.D. from the University of Minnesota in 1951 and since that time has been farming in North Dakota. He replaces Rex D. Rehnberg who resigned to accept a similar position at Colorado A & M.

David Volkin has accepted a position as Business Analyst with the St. Paul Bank for Cooperatives.

Chester M. Wells has returned to Mississippi State College following a year of graduate study at the University of Illinois.

Walter Wilcox, Legislative Reference Section, Library of Congress, conducted a series of Seminars on Agricultural Policy and Farm Management Research while a visiting professor at Washington State College for the two week period October 13-24.

Lawrence W. Witt returned in January from a three months sojourn in Brazil, during which he brought up-to-date his earlier studies of agricultural changes and economic development. He will remain on leave from Michigan State College until June 1. Throughout the remainder of his leave he will lecture and conduct seminars at a number of universities under the auspices of the American Universities Field Staff, Inc. In his absence Raleigh Barlowe is serving as acting editor of the *Journal*.

Martin D. Woodin has returned to his position as Professor of Agricultural Economics at Louisiana State University after a six-month leave of absence with the Mutual Security Agency. He headed a team of specialists who studied the sugar industry in Taiwan for the Chinese Nationalist Government.

LEWIS CECIL GRAY
1881–1952

Lewis C. Gray, first chief of the Division of Land Economics of the U. S. Department of Agriculture and long a leader in this field, died at his home near Raleigh, N.C. on November 18. He was President of this Association in 1928.

Dr. Gray was born at Liberty, Mo., December 2, 1881. He received his A.B. degree from William Jewell College in 1900, his M.A. in 1903 and an LL.D. in 1927. A secondary school principal from 1903 to 1905, he then taught history and economics at Oklahoma A and M until 1908, taking summer graduate work at the University of Chicago. In 1908 he entered the graduate school of the University of Wisconsin where the influence of R. T. Ely, H. C. Taylor, J. R. Commons and others profoundly shaped his thinking and his future career. He devoted major attention to agricultural economics with special reference to land problems. Awarded a Ph.D. by the University of Wisconsin in 1911, Dr. Gray served as instructor there until 1913 when he joined the teaching staff of the University of Saskatchewan. In 1915 he became a member of the faculty of the George Peabody College for Teachers at Nashville.

In 1919 he was appointed chief of the newly established Division of Land Economics in the U. S. Department of Agriculture. To this organization he gave inspired and productive leadership over a period of almost two decades. A brilliant scholar, he contributed many important bulletins and articles. He wrote two widely recognized books. His *Introduction to Agricultural Economics* served as a particularly useful text during the 1920's. His two volume *History of Agriculture in Southern United States to 1860*, published in 1933, was then, and still is, regarded as a work of prime and permanent significance.

In 1922 and again in 1928 Dr. Gray represented the U. S. Department of Agriculture at meetings of the International Institute of Agriculture in Rome. In 1931 he played an active part in the National Conference on Land Utilization. He served as executive secretary of the National Land Use Planning Committee and assisted substantially in the work of the National Legislative and Advisory Committee on Land Use, two agencies established on recommendation of the Conference. Dr. Gray's solid work and far reaching influence did much to further the establishment in the early 1930's of national programs for submarginal land retirement and rural land use planning. Beginning in 1934 he served concurrently as head of the Division of Land Economics and, successively, as Chief of the Land Policy Section of the A.A.A., and then as Assistant Administrator of the Resettlement Administration in charge of its Land Utilization Division. During this period he served as director of the land section of the National Resources Board and as a member of numerous national and interdepartmental committees, among them the President's Great Plains Committee, and the President's Committee on Farm Tenancy of which he was executive secretary. Following transfer of the Resettlement Administration land program activities to the Department of Agriculture in 1937, he became Assistant Chief of BAE. He retired from the Bureau for disability in 1941. Able economist and devoted public servant, Dr. Gray leaves enduring contributions to agricultural economics, agricultural history, and land policies in the public interest.

E. H. W.
H. C. T.

Announcing . . .

3 New Farm Economics Texts

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